SF Public Works

STRUCTURAL CALCULATIONS
SAN FRANCISCO BRIDGE SEISMIC EVALUATION
BRIDGE GROUPS IIA AND V

Seismic ...

DOCUMENTS DEPT

JAN 14 1987

D
REF
624.252
Se4507

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January 25, 1985

Mr. Joe Ovadia, Project Manager
Department of Public Works
Bureau of Engineering
Room 351, City Hall
San Francisco, CA 94102

Subject: DPW Order 132,428
Seismic Evaluation of Bridges
Transmittal of Final Report

Dear Mr. Ovadia:

We are pleased to transmit the following:

- Three copies of the final report "Seismic Safety Evaluation of Existing San Francisco Bridges, Group IIA and V", Volume 1, November 1984.

- Three copies of "Geotechnical Investigation, Seismic Safety Evaluation of Existing San Francisco Bridges", September 1984, by Allstate Geotechnical Services. This is considered as Volume II of the total report.

- One set of structural calculations.

Computer printouts are voluminous and it is not practical to reproduce them. However, we would be able to loan them to the Bureau of Engineering on a temporary basis.

We have enjoyed working with you on this project and we look forward to a continuing good relationship with you and the Department of Public Works.

Very truly yours,

Phil Griffin

Philip G. Griffin
Project Manager

cav

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SF Public Works
Seismic Safety Evaluation of Existing San Francisco Bridges

5/S

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evaluation of existing
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SHEET NO.

NO. 8438 JOB S.F. BRIDGE SEISMIC EVALUATIONS BY RCG DATE 1/11/85
ENT SUBJECT MARKET STREET VIADUCTS CHK'D DATE
1, 2, 5, 6 & 4

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SHEET NO. 1

NO. 9439 JOB SF BRIDGES BY GLM DATE 10/12/94

ENT SUBJECT MARKET STREET VIADUCTS 1, 2, 5 & 6 CHK'D DATE

DESCRIPTION

VIADUCTS 1 AND 2 ARE VERY SIMILAR, EACH BRIDGE IS ABOUT 40' WIDE. THE BRIDGE DECKS ARE EACH 12" THICK SUPPORTED BY BENT CAPS WHICH ARE 18" DEEP AND 24" WIDE. THE BENTS ARE SPACED AT 20' ON CENTER. EACH BENT CONSISTS OF 2 VERTICAL 24" DIAMETER CONCRETE PILES LOCATED 16' TO EACH SIDE OF THE BRIDGE DECK CENTERLINE. IN ADDITION 2 BATTERED PILES ALSO WITH 24" DIAMETERS EXIST AT 2' TO EACH SIDE OF THE CENTERLINE FOR EACH BENT. THE BATTER IS AT A SLOPE OF 4 VERTICAL TO 1 HORIZONTAL. THE PILES ARE EXPOSED ABOVE THE GROUND SURFACE ANYWHERE FROM 0' TO 5'. THE PILES ARE APPROXIMATELY 35' LONG. EVERY 4 TO 5 SPANS ALONG THE BRIDGE DECKS VERTICAL HINGES OCCUR, i.e. THEY ONLY CAN TRANSMIT VERTICAL SHEAR. IN THE DIRECTION LONGITUDINAL TO THE BRIDGE DECK THE PILES IN THE BENTS CLOSEST TO THE HINGES ARE PINNED

VIADUCTS 5 & 6 ARE SIMILAR TO VIADUCTS 1 & 2. THE DIFFERENCES ARE THAT VIADUCTS 5 & 6 HAVE BATTERED PILES ONLY AT A FEW BENTS. AT THE OTHER BENTS THE 2 BATTERED PILE IS REPLACED BY ONE VERTICAL PILE AT THE BRIDGE CENTERLINE. ALSO THE PILES ARE TOTALLY EMBEDDED.

COMPUTER MODELING

SINCE THE BRIDGE DECK HINGES TRANSMIT NO LATERAL SHEAR OR ANY MOMENTS, AND SINCE THEY TRANSMIT NO LONGITUDINAL FORCES (UNLESS THE DEFLECTION IS MORE THAN 1") THE BRIDGE CAN BE ANALYZED AS INDIVIDUAL SEGMENTS FROM HINGE TO HINGE. SINCE VIADUCTS 1 & 2 ARE SO SIMILAR 1 MODEL WILL BE USED AS REPRESENTATIVE OF BOTH BRIDGES.

THE MODEL WILL CONSIST OF 4 BENTS SPACED 20' APART. A 15' SPAN WILL EXTEND BEYOND THE FIRST BENT, AND A 5' SPAN WILL EXTEND BEYOND THE 4TH BENT. THE END OF THESE SPANS WILL BE SUPPORTED VERTICALLY BY FICTITIOUS ABUTMENTS WHICH REPRESENT THE HINGES.

DUE TO THE HIGH LOADS ANTICIPATED FROM THE ANALYSIS, IT WILL BE ASSUMED THAT THE CONNECTIONS BETWEEN THE BENT CAP AND THE PILES WILL BE OVERSTRESSED IN BENDING AND THEREFORE PRODUCE A PLASTIC HINGE. FOR THIS REASON, ALL THE PILES WILL BE ASSUMED TO BE PINNED AT THE TOP. EVEN THOUGH THE PILES ARE EXPOSED ON THE AVERAGE ONLY 3', THE COLUMN HEIGHTS ENTERED WILL BE 9'. THIS ASSUMES A FIXED CONDITION AT THE BASE, i.e. A FIXED CONDITION AT 3 PILE DIAMETERS BELOW THE SURFACE.

THE "SEISAB" PROGRAM DOES NOT ALLOW FOR THE DIRECT INPUT OF BATTERED PILES (ONLY VERTICAL PILES CAN BE USED). BATTERED PILES HAVE A MUCH HIGHER LATERAL STIFFNESS THAN DO VERTICAL PILES SINCE SOME OF THE LOAD CAN BE TAKEN IN AXIAL COMPRESSION AND TENSION. TO ACCOUNT FOR THE ADDED STIFFNESS THE MOMENT OF INERTIA FOR BENDING ABOUT THE LONGITUDINAL BRIDGE AXIS WILL BE INCREASE BY A FACTOR OF 3.0 FOR THE BATTERED PILES.

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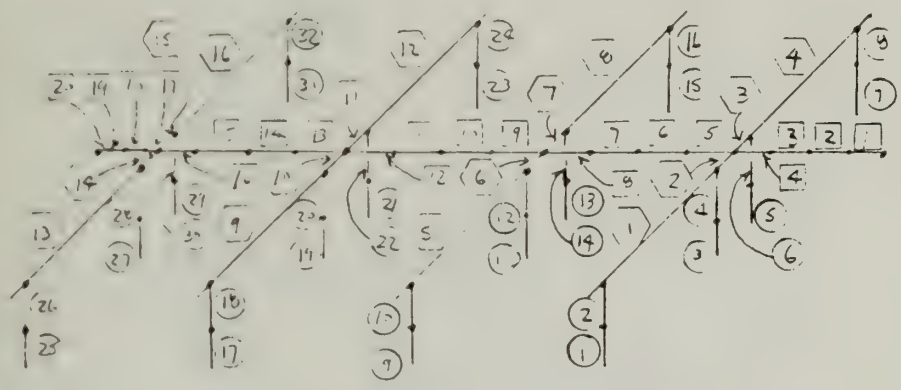
SHEET NO. 3

NO. 9436 JOB SF BRIDGES BY GLM DATE 1/5/1/...

NT SUBJECT MARKET ST VIADUCT 1 2 5 9 6 CHK'D DATE

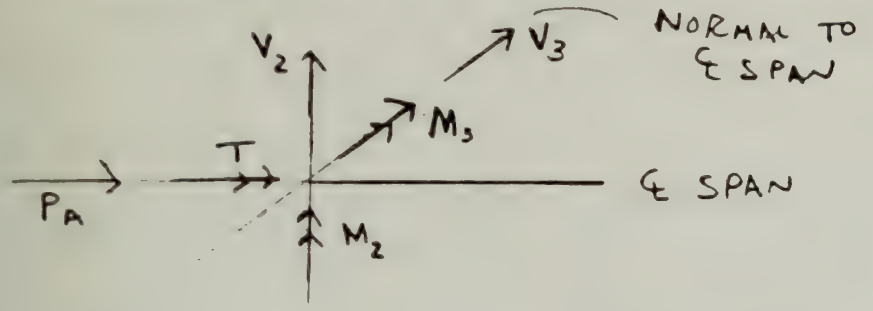
COMPUTER MODEL



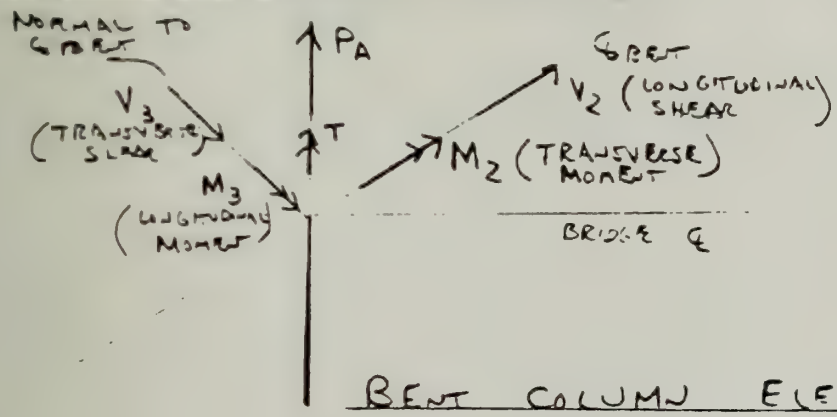
□ - SPAN ELEMENT

○ - BENT COLUMN ELEMENTS

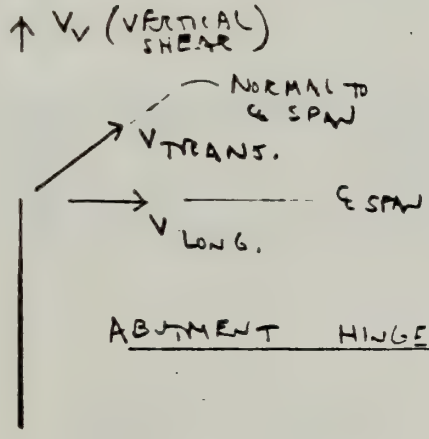
⬡ - BENT CAP ELEMENTS

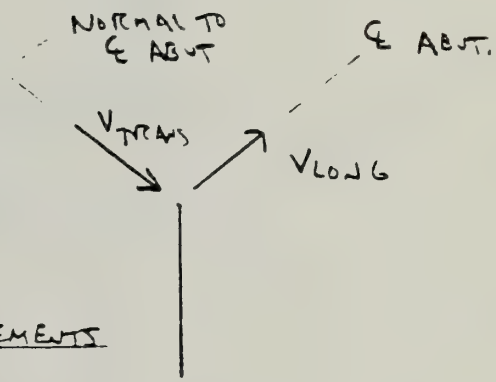



SPAN ELEMENTS




BENT COLUMN ELEMENTS

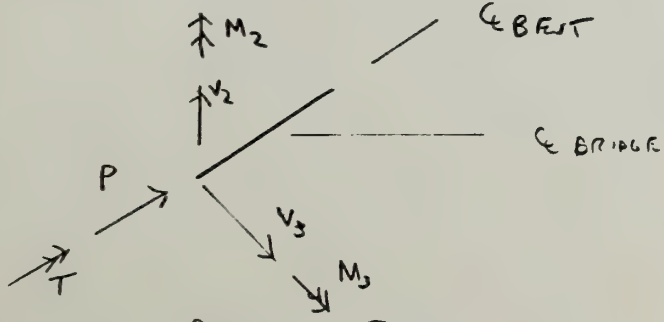



ABUTMENT HINGE ELEMENTS

W/R TO BRIDGE ℄

W/R TO ITEM ℄




BENT CAP

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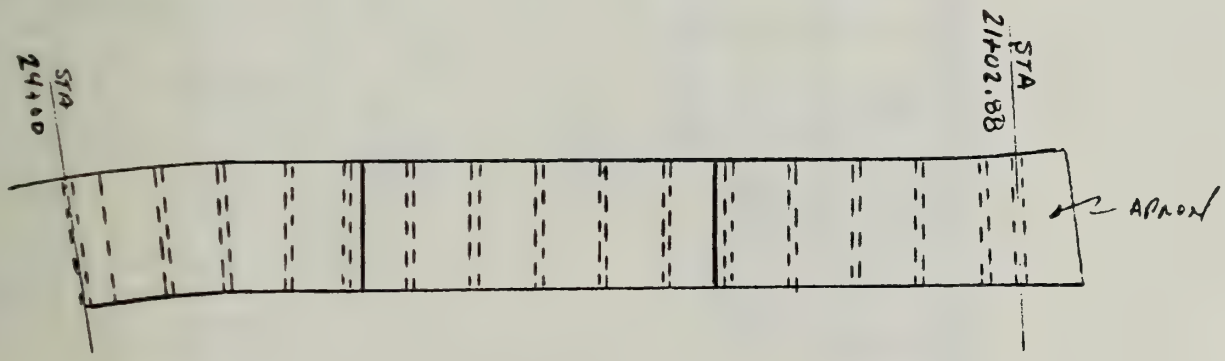
SIDE HILL VIADUCT NO. 1




SIDEHILL VIADUCT NO. 2

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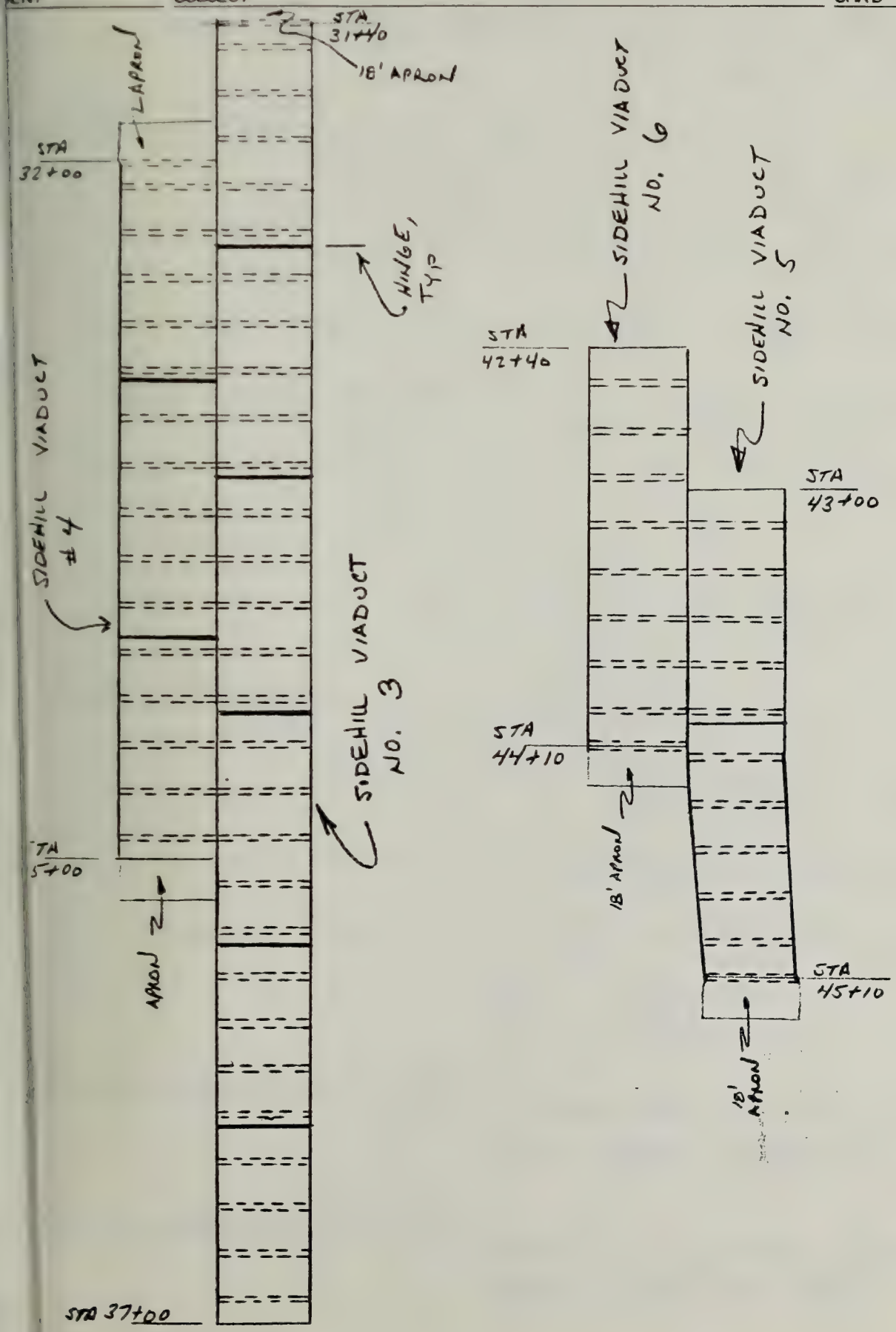
SHEET NO. 6

B NO. JOB BY DATE

ENT SUBJECT CHK'D DATE



PILES, 24"φ / A: I:

SIDEHILL VIADUCT #1

WIDTH = 31'+8' + VARIES (0 to 21"±) = 39' ± VARIES

USE 40'-0 ; 12" SLAB FOR SECTION PROPERTIES.

A = 40' × 12 × 12" = 5760 in² (40 ft²)

$I_{11}$ (VERT AXIS) = 12 × 480³ × 1/12 = 110.59 × 10⁶ in⁴ (5,333. ft⁴)

$I_{22}$ = 480 × 12³ × 1/12 = 69120. in⁴ (3.33 ft⁴)

WEIGHT OF TYP SEGMENT =

$\left\{ 20' \times \left[ 40' \times 1' + 8' \times 0.58' + \frac{19\frac{1}{2}" \times 8"}{144} \right] + \frac{18" \times 24"}{144} \times 40' + \frac{2"}{12} \times 31' \times 20' \right\} \times 0.15 = 170.2$ KIPS PER 20'

A.C. ASSUMED @ 150 PCF

USE AVG WEIGHT = $\frac{170.2}{20}$ = 8.51 K/'

SIDEHILL VIADUCT #2

WIDTH = 32'+8'+ VARIES (0 to 21"±) = 40'± VARIES. USE 41'-0 FOR SECTION PROP.

A = 41' × 12"/' × 12" = 5904 in² (41 ft²)

$I_{11}$ (VERT) = 12 × 492³ × 1/12 = 119.09 × 10⁶ in⁴ (5743 ft⁴)

$I_{22}$ = 492 × 12³ × 1/12 = 70848 in⁴ (3.42 ft⁴)

WEIGHT = SAME AS (1) + $\frac{14"}{12}$ × 1' × 20' × 0.15 = 170.2 + 3.5
= 173.7 K/20'

WT/' = $\frac{173.7}{20}$ = 8.69 K/'

SIDEHILL VIADUCTS #3 & 4

WIDTH = SAME AS #2, USE PROP FROM SIDEHILL VIADUCT #2 ABOVE.

SIDEHILL VIADUCTS #5 & 6

WIDTH = ?, USE SAME PROPERTIES AS SIDEHILL VIADUCT #2 ABOVE.

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SHEET NO. 8
NO. 8438 JOB BY FTS DATE 7-84
NT SUBJECT MARKET ST. VIADUCTS CHK'D DATE

SEISAB INPUT MARKET ST. VIADUCT # 1

SEISAB "MARKET ST. VIADUCT NO. 1"
FREQUENCY ANALYSIS
COLUMN JOINTS 0
SUPERSTRUCTURE JOINTS ____
SPANS
LENGTHS 15. 17*20. 15.
AREA 40.
I11 .0001
I22 5333.
I33 3.33
DENSITY 0.0
WEIGHT 8.51 E 410400
DESCRIBE
COLUMN "COL" "24 IN ROUND R/C"
AREA 3.14159
I11 0.00001
I22 0.7854 > $\pi r^4/4$
I33 0.7854
CAP "CAP" "30 IN x 24 IN R/C"
AREA 5.0
I11 0.0001
I22 1.6666
I33 2.6042
DENSITY 0.0
E 410400
ABUTMENT STATION, 0.0 + 0.0
ELEVATION 370., 395.
WIDTH NORMAL 40.
CONNECTION PIN, PIN

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SHEET NO. 9

NO. JOB BY DATE
NT SUBJECT CHK'D DATE

MARKET ST. VIADUCT #1 ; SOISAB INPUT

BENT
ELEVATION TOP 371.3, 372.6, 373.9, 375.3, 376.6, 377.9, 379.2, 380.5, —
381.8, 383.2, 384.5, 385.8, 387.1, 388.4, 389.7, 391.0, 392.4, 393.6
HEIGHT 9.
CAP "CAP" AT 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
COLUMN NORMAL LAYOUT 'COL' 16. 'COL' 4. 'COL' 16. 'COL' AT 2, 3, 4, —
5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
HINGE
AT 6 5.
TORSION FREE
LONGITUDINAL FREE
TRANSVERSE PIN
AT 10 5.
TORSION FREE
LONGITUDINAL FREE
TRANSVERSE PIN
AT 14 5.
TORSION FREE
LONGITUDINAL FREE
TRANSVERSE PIN
LOADS
FREQUENCY ANALYSIS
FINISH

S

1EOF

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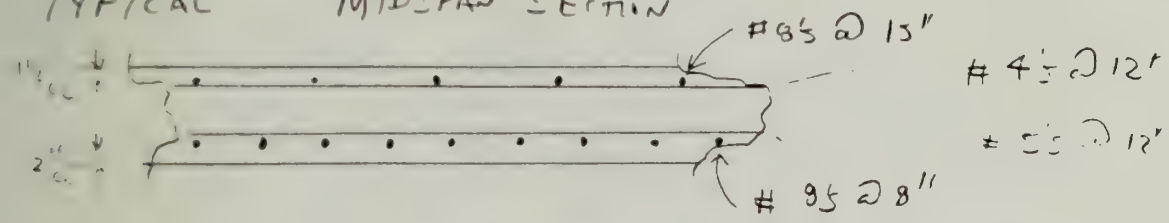
SHEET NO. 10

NO. 9439 JOB SF BRIDGES BY GLM DATE 9/29/86

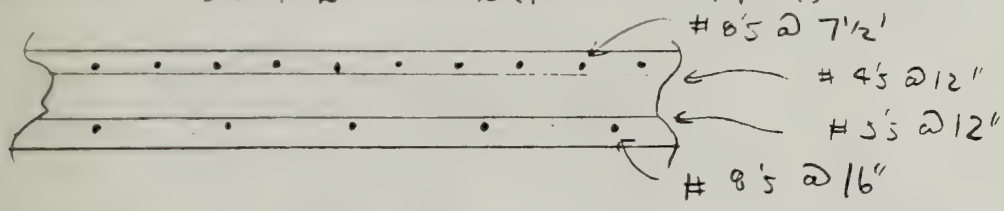
SUBJECT MARKET ST. VIADUCT 1, 2, 5, & 6 CHK'D DATE

ROADWAY SLAB

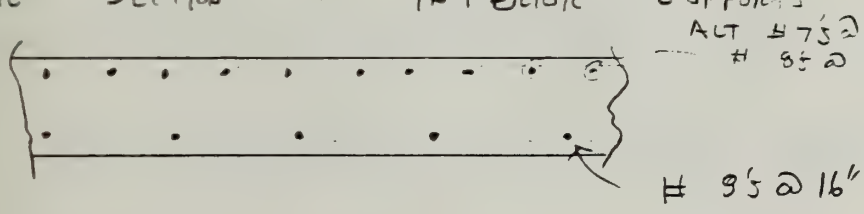
TYPICAL MIDSPAN SECTION




TYPICAL SECTION @ EXTERIOR SUPPORTS




TYPICAL SECTION @ INTERIOR SUPPORTS



ROADWAY SLAB

MIDSPAN SECTION – POSITIVE MOMENT

ALLOWABLES

BENDING ABOUT HORIZ AXIS

$$a = \frac{A_s f_y}{.85 f'_c b} = \frac{(1.18 \text{ in}^2)(40 \text{ ksi})}{.85(2.5 \text{ ksi})(12'')} = 1.85''$$

$$d = 12'' - 2'' - 0.5'' = 9.5''$$

$$M_{u_3}^{+} = (0.9)(1.18)(40)(40')\left(9.5 - \frac{1.85}{2}\right) = 1214 \text{ ft-k}$$

BENDING ABOUT VERTICAL AXIS

ACTS AS A DEEP BEAM

ASSUME ONLY STEEL IN OUTER 1/10 OF SLAB ACTS IN TENSION $\frac{l}{10} = 4'$, IGNORE COMPRESSION STEEL

ASSUME TRIANGULAR COMPRESSION BLOCK EQUAL TO 2/3 d

$$A_s = 1.18 \frac{\text{in}^2}{\text{ft}}(4') + \left(0.63 \frac{\text{in}^2}{\text{ft}}\right)(4') = 7.24 \text{ in}^2, \quad d = 38'$$

$$M'_{u_2} = (0.9)(7.24)(40 \text{ ksi})\left(\frac{2}{3}\right)(38') = 6603 \text{ ft-k}$$

AXIAL LOAD

TENSION (ASSUME ONLY STEEL ACTS)

$$P_{a_T}' = (0.9)(1.18 + 0.63)(40')(40 \text{ ksi}) = 2606^{k}$$

COMPRESSION

$$P_{o_c}' = A_g f'_c \div 10 = 40'(1')(2500 \text{ psi})\left(144 \frac{\text{in}^2}{\text{ft}^2}\right)\left(\frac{1}{10}\right) = 1440 \text{ KIPS}$$

LOADS

$$P_{MAX} = 183^{k} << P_o' \quad \text{(IGNORE AXIAL LOADS)}$$

$$M_{2MAX}\ \text{ELEM 10'} = 1526 \text{ ft-k}\left(\frac{1}{2.0}\right)_{\text{C.Z}} = 763 \text{ ft-k}$$

$$M_{3\,MAX}\ \text{ELEM 15'} = 173_{DL} + 0.3(134 = 213 \text{ ft-k}$$

$$R = \frac{M_2}{M'_{2u}} + \frac{M_3}{M'_{3u}} = \frac{763}{6603} + \frac{213}{1214} = 0.12 + 0.18 = 0.30 < 1.0 \text{ OK.}$$

ROADWAY SLAB

@ INTERIOR SUPPORT

BENDING ABOUT HORIZ. AXIS

$a = \frac{(1.11)(40)}{.85(2.5)(12)} = 1.74''$

$d = 12 - 1.5 - 0.5 = 10''$

$M_{u_3}^{(+)} = 0.9(1.11)(40)(10 - \frac{1.74}{2})(40') = 1216$ ft-k

BENDING ABOUT VERTICAL AXIS

$A_S = (1.11 \frac{in^2}{'})(4') + (0.63 \frac{in^2}{'})(4') = 6.96 in^2$ $d = 39'$

$M_{u_2}' = 0.9(6.96)(40)(\frac{2}{3})(39) = 6349$ ft-k

IGNORE AXIAL LOAD

LOADS

$M_{2\ MAX\ Elem\ 4j} = 1628$ ft-k $(\frac{1}{2.0}) = 814$ ft-k

$M_{3\ Elem\ 4j} = \underset{DL}{259} + 0.3(21.5) = 265$ ft-k

$R = \frac{814}{6349} + \frac{265}{1216} = 0.13 + 0.22 = 0.35 < 1.0$ o.k.

SHEAR

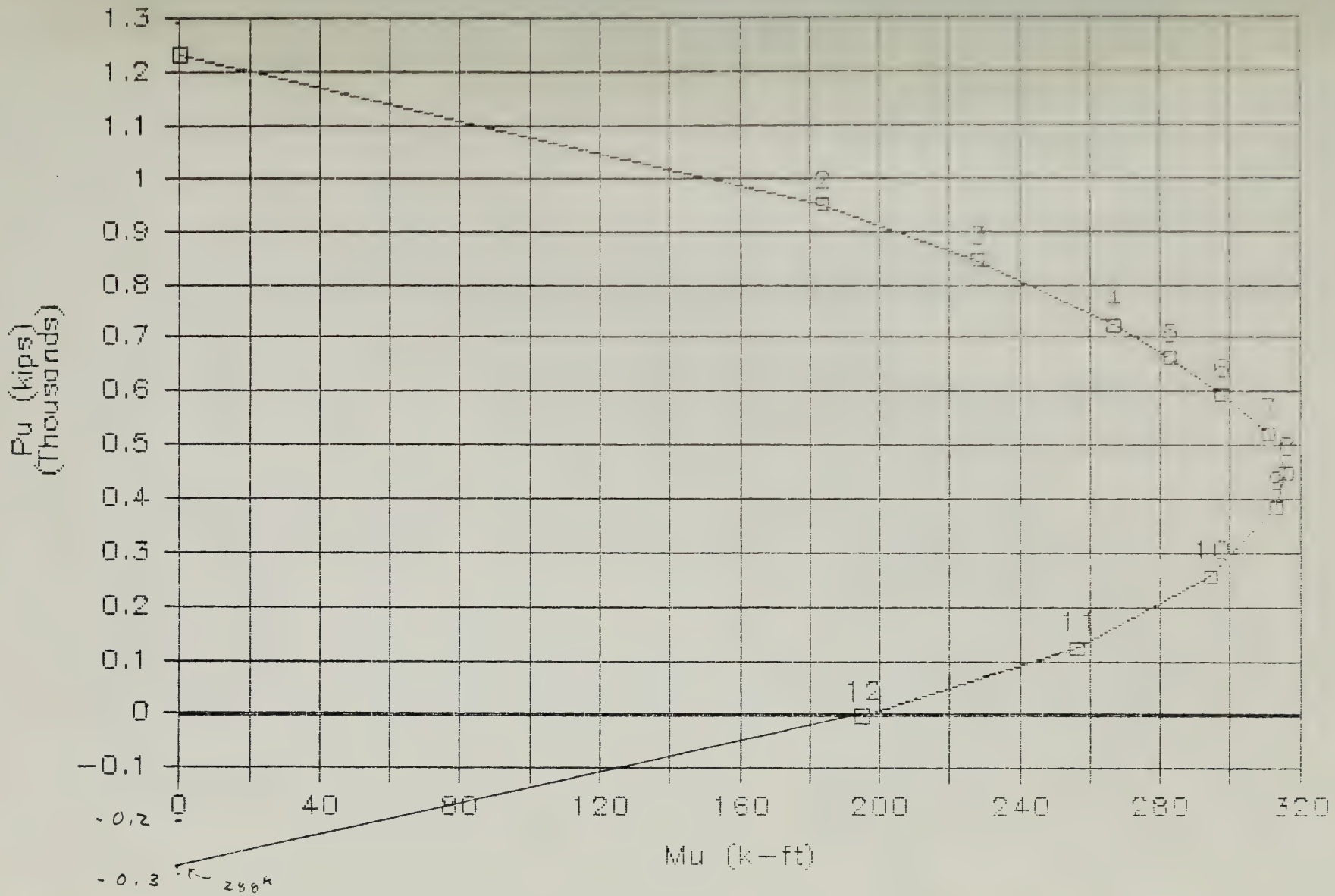
$V_{2\ MAX\ Elem\ 13i} = \underset{DL}{90.0^k} + \underset{SEIS}{27.5} = 117.5^k$

$V_{3\ MAX\ Elem\ 4} = \underset{SEIS}{182^k}$

$V_{all} = 0.85\ 2\sqrt{2500}(40)(12)(12)\frac{1}{1000} = 490^k$

SHEAR IS o.k.

# Column Interaction Diagram



| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Es | = | 29000 | ) | Dc= | ( | 24 | ) | as= | ( | 0.6 | ) | | CIRCCOL | | |
| fy | = | 40 | ) | Ds= | ( | 17 | ) | nb= | ( | 12 | ) | | | | |
| fc | = | 2.5 | ) | B1= | ( | 0.85 | ) | | | | | | | | |
| units | : | Kst | | Cb= | ( | 14.04 | ) | | | | | | | | |

COL: (24" PILE )

| point | Pu | Mu k-in | Mu k-ft | c |
|---|---|---|---|---|
| 1 | 1234.0 | 0.0 | 0.0 | |
| 2 | 951.1 | 2205.2 | 183.8 | 21.01 |
| 3 | 845.3 | 2733.9 | 227.8 | 19.02 |
| 4 | 725.2 | 3200.4 | 266.7 | 17.03 |
| 5 | 643.3 | 3390.5 | 282.5 | 16.03 |
| 6 | 545.4 | 3571.0 | 297.6 | 15.04 |
| 7 | 5[illegible].5 | 3723.4 | 310.7 | 14.04 |
| 8 | 45[illegible].5 | 3790.2 | 315.9 | 13.05 |
| 9 | 3[illegible].4 | 3757.0 | 313.1 | 12.05 |
| 10 | 256.7 | 3531.2 | 294.3 | 10.06 |
| 11 | 124.9 | 3075.1 | 256.3 | 8.07 |
| 12 | -1.7 | 2339.5 | 195.0 | 6.08 |

Note:

Dc: concrete sect dia
Ds: reinf. ring dia
as: single bar area
nb: no. of bars
5 =< nb <= 19

press [PgDn] for factored loads

press F5 HELP [ENTER] for help

CAPS

SEISMIC ANALYSIS

COMPUTER RUN GLMSEISAB2.OUT COMPUTES THE FUNDAMENTAL FREQUENCIES OF THE BRIDGE

LONGITUDINALLY THE FREQUENCY IS 3.935 hz,
$S_a = 1.62g$, $\Gamma = -4.685$

TRANSVERSELY THE FREQUENCIES ARE $f_1 = 10.755$ hz, $f_2 = 13.341$ hz
$S_{a_1} = 1.27g$, $S_{a_2} = 1.18g$, $\Gamma_1 = 3.247$, $\Gamma_2 = 3.454$

CHECK TO SEE HOW MUCH RESPONSE HAS BEEN CAPTURED:

$$\text{MASS MODEL} = \left(\frac{1}{32.2}\right)\left[80'(0.41k/') + 3/4(9')(3.14\square')(.15k/ft)(6)\right]$$
$$= \left(\frac{1}{32.2}\right)(.724) = 22.47 \ \frac{k\text{-sec}^2}{ft}$$

LONGITUDINAL

$$\text{MASS CAPTURED} = \Gamma^2 = (4.685)^2 = 21.95 \ \frac{k\text{-sec}^2}{ft}$$
$$\%\ \text{MASS CAPTURED} = \frac{21.95}{22.47} \times 100\% = 98\% \quad \text{O.K.}$$

TRANSVERSE

$$\text{MASS CAPTURED} = \Sigma\Gamma^2 = (3.247)^2 + (3.454)^2 = 22.47$$
$$\%\ \text{MASS CAPTURED} = 100\%$$

BASE SHEAR

THE BASE SHEAR IS EQUIVALENT TO: $\sum_{i=1}^{n} \Gamma_i^2 S_{a_i}$

$$V_{LONG} = (4.685)^2(1.62)(32.2) = 1145^k$$

$$V_{TRANS} = \left[(3.247)^2(1.27) + (3.454)^2(1.18)\right](32.2) = 884^k$$

FOR SIMPLICITY ASSUME ENTIRE LOAD IS AT BRIDGE DECK

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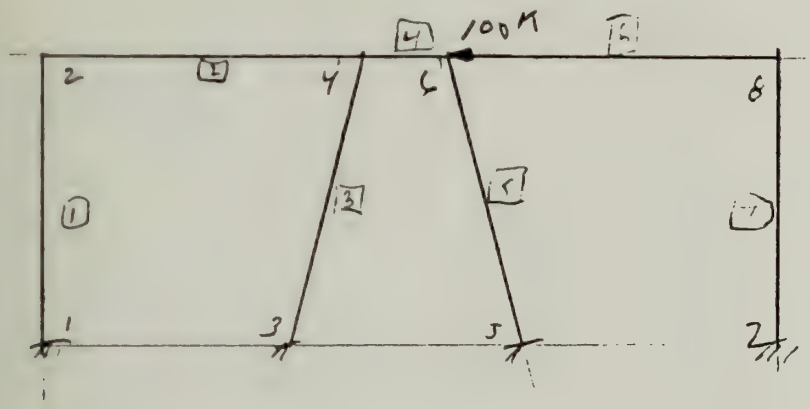
SHEET NO. 15

NO. 6738 JOB MARKET ST. VIADUCT BY PGG DATE 10-11-89

NT SUBJECT FRAME 2C CHK'D DATE




HED: MARKET ST. VIADUCT BENT.

CONTROL CARD

NUMEL = 7
NUMND = 8
NUMMAT = 1
NUMELA = 3
NUMSAR = 0
NUMFIX = 0
NUMJF = 1

MATERIAL CARD

N = 1
E = 410000

NUMETA CARDS

N=1 COAX = 3.142 COAZ = 0.785
N=2 COAX = 5.0 COAZ = 2.60
N=3 COAX = 0.51 COAZ = 0.785

NUMJF CARD

N = 1 SJF (12) = -100

RS/BLUME

Jessie Street (at New Montgomery)

Francisco, California 94105

SHEET NO. 16

NO. E438 JOB MARKET ST. VIADUCT BY PGG DATE 10-11-69

NT SUBJECT CHK'D DATE

NUMPT CARDS

| | | | | |
|---|---|---|---|---|
| N=1 | MODE = 111 | X = 0.0 | Y = 0.0 | JF(1) |
| N=2 | 000 | 0.0 | 9.0 | |
| N=3 | 111 | 12.25 | 0.0 | |
| N=4 | 000 | 14.5 | 9.0 | |
| N=5 | 111 | 19.75 | 0.0 | |
| N=6 | 000 | 17.5 | 9.0 | 1 |
| N=7 | 111 | 32.0 | 0.0 | |
| N=8 | 000 | 32.0 | 9.0 | |

ELEMENT DATA CARDS

| | | | | | | |
|---|---|---|---|---|---|---|
| IMEL = | 1 | I = 1 | J = 2 | IMAT = 1 | IMEL = 1 | INEW = 11111 |
| | 2 | 2 | 4 | 1 | 2 | 11111 |
| | 3 | 3 | 4 | 1 | 1 | 11111 |
| | 4 | 4 | 6 | 1 | 2 | 11111 |
| | 5 | 5 | 6 | 1 | 3 | 11111 |
| | 6 | 6 | 8 | 1 | 2 | 11111 |
| | 7 | 7 | 8 | 1 | 1 | 11111 |

STREET VIADUCT BENT

FRAME 2-C

OCT. 11, 1984

| | | |
|---|---|---|
| R OF ELEMENTS | = | 7 |
| R OF NODAL POINTS | = | 8 |
| R OF MATERIALS | = | 1 |
| R OF ELEMENT TYPES | = | 3 |
| R OF ELASTIC SUPPORT TYPES | = | 0 |
| R OF FIXED END FORCE TYPES | = | 0 |
| R OF JOINT FORCE TYPES | = | 1 |

| AL | YOUNG S MODULUS | POISSON S RATIO |
|---|---|---|
| | 410000. | .00000 |

| T | AXIAL AREA | SHEAR AREA | MOMENT OF INERTIA |
|---|---|---|---|
| | 3.142 | .000 | .785 |
| | 5.000 | .000 | 2.600 |
| | .510 | .000 | .785 |

FORCE CARDS

| X | Y | R |
|---|---|---|
| -100.000 | .000 | .000 |

| | NODAL COORDINATES | | BOUNDARY CONDITIONS | | | ELASTIC SUPPORT |
|---|---|---|---|---|---|---|
| DE | X | Y | X | Y | Z | TYPE |
| 11 | .000 | .000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | .000 | 9.000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 11 | 12.250 | .000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | 14.500 | 9.000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 111 | 19.750 | .000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | 17.500 | 9.000 | -100.000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 111 | 32.000 | .000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | 32.000 | 9.000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |

| NT | NODE I | NODE J | MATERIAL TYPE | ELEMENT TYPE | ELEMENT CODE | FIXED END FORCE TYPE | STIFFNESS KIJ | KJI | CIJ |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 1 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 2 | 4 | 1 | 2 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 3 | 4 | 1 | 1 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 4 | 6 | 1 | 2 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 5 | 6 | 1 | 3 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 6 | 8 | 1 | 2 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| | 7 | 8 | 1 | 1 | 0 | 0 | 4.0 | 4.0 | .5 |
| | | | | | | 0 | | | |
| | | | | | | 0 | | | |

| T | X-DISPLACEMENT | Y-DISPLACEMENT | Z-ROTATION |
|---|---|---|---|
| | .00000 | .00000 | .00000 |
| | .00000 | .00000 | .00000 |
| | .00000 | .00000 | .00000 |
| | -.00453 | -.00004 | .00030 |
| | .00000 | .00000 | .00000 |
| | .00000 | .00000 | .00000 |
| | .00000 | .00000 | .00000 |
| | .00000 | .00000 | .00000 |

| | | |
|---|---|---|
| .00000 | .00000 | .00000 |
| -.00465 | .00083 | .00002 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| -.00473 | .00074 | -.00001 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| -.00459 | .00006 | .00021 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |

MEMBER END FORCES

| NT | AXIAL I | SHEAR I | MOMENT I | AXIAL J | SHEAR J | MOMENT J |
|---|---|---|---|---|---|---|
| 1 | 6.127 | -16.845 | -86.567 | -6.127 | 16.845 | -65.035 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 2 | 16.845 | 6.127 | 65.035 | -16.845 | -6.127 | 23.809 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 3 | 44.982 | -22.348 | -104.376 | -44.982 | 22.348 | -102.942 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 4 | 49.435 | 44.346 | 79.133 | -49.435 | -44.346 | 53.905 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 5 | -42.116 | -21.637 | -99.848 | 42.116 | 21.637 | -100.877 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 6 | -19.360 | 8.735 | 46.972 | 19.360 | -8.735 | 79.691 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| 7 | -8.735 | -19.360 | -94.545 | 8.735 | 19.360 | -79.691 |
| | .000 | .000 | .000 | .000 | .000 | .000 |
| | .000 | .000 | .000 | .000 | .000 | .000 |

APPLIED JOINT LOADS AND REACTIONS

| FORCE X | FORCE Y | MOMENT Z |
|---|---|---|
| 16.845 | 6.127 | -86.567 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |

| | | |
|---|---|---|
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| 32.590 | 38.219 | -104.376 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| 31.205 | -35.611 | -99.848 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| -100.000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| 19.360 | -8.735 | -94.545 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |

FOR $P_{11} = 100^K$, $\Delta = 0.00473'$

$$\therefore K = \frac{100}{.00472} = 21140 \ ^K/FT.$$

S/BLUME
Jessie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 21

NO. 6438 JOB MARKET ST. VIADUCT #1. BY PGG DATE 10/12/6?

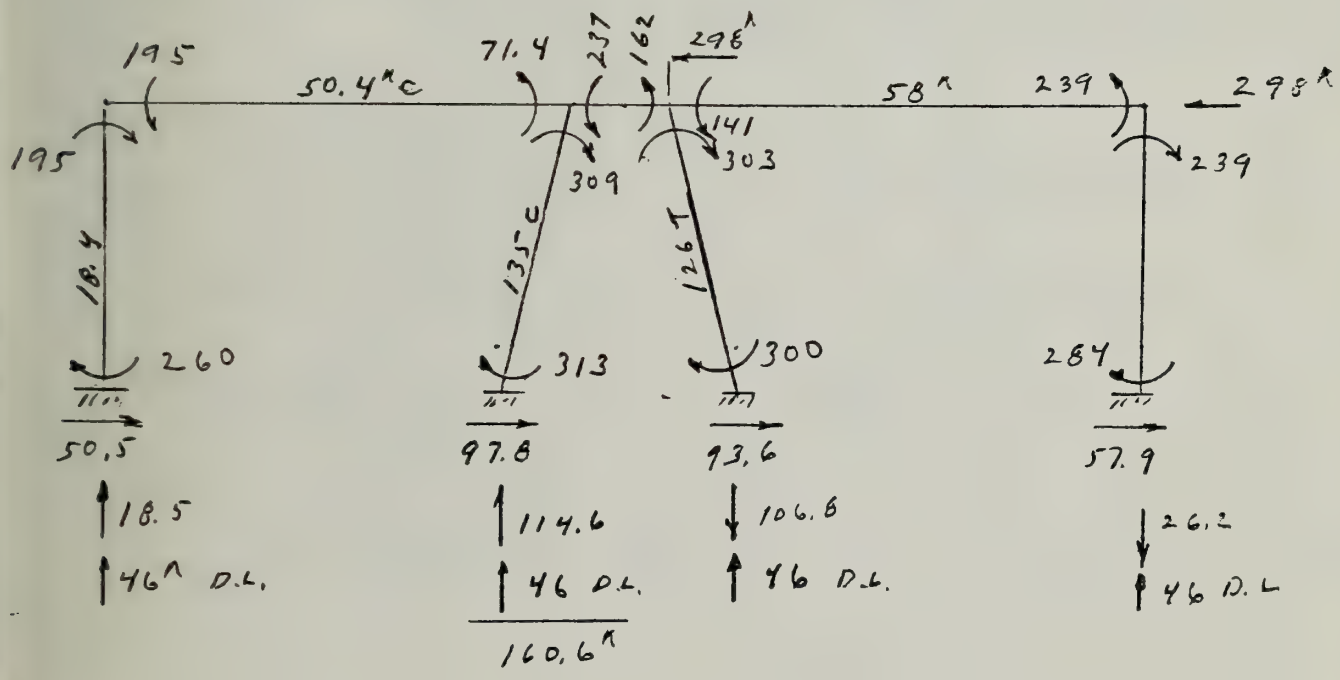
IT SUBJECT CHK'D DATE

COMPARE SEISAB WITH FRAME 2C

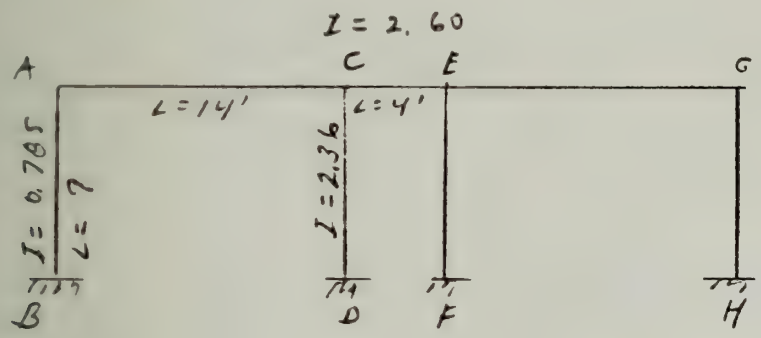
COMMENT: FRAME 2C GIVES CORRECT CONFIGURATION OF TRANSVERSE BENT. MOMENTS AND SHEARS ARE CALCULATED FOR 100K TRANSVERSE FORCE.

SEISAB ANALYSIS ASSIGNS A MAXIMUM BENT SHEAR OF 298K TO BENT #1.

FOR STRESS CHECK, INCREASE FRAME 2C OUTPUT BY 298/100 ≈ 3.0



1) CALCULATE STIFFNESS OF BENT AS MODIFIED




$E = 410{,}000$ KSI

$\Delta = \frac{PL^3}{12EI} = 1$

$P_{AB} = \frac{12EI}{L^3}$

$= \frac{12 \times 410 \times 10^3 \times 0.785}{9^3}$

$= 5300^K$

$P_{CD} = 3P_{AB} = 15900^K$

$FEM_{AB} = 4.5 \times 5300 = 23850^{IK}$

$FEM_{CD} = 4.5 \times 15900 = 71550$

DIST FACTORS

AB: $\frac{I}{L} = \frac{0.785}{9} = 0.088$

CD: $\frac{I}{L} = \frac{2.36}{9} = 0.263$

AC: $\frac{I}{L} = \frac{2.60}{14} = 0.186$

CE $\frac{I}{L} = \frac{2.60}{4} = 0.650$

$DIST_{AB} = \frac{.088}{.088 + .186} = 0.319$

$DIST_{AC} = 0.681$

$DIST_{CA} = \frac{0.186}{.186 + .263 + .650} = 0.169$

$DIST_{CD} = \frac{0.263}{1.099} = 0.239$

$DIST_{CE} = 0.592$

BENT STIFFNESS - CONT.

| | BA | AB | AC | CA | CD | DC | CE | EC |
|---|---|---|---|---|---|---|---|---|
| DIST. | 0 | .319 | .681 | .169 | .239 | 0 | .592 | |
| FEM/$10^3$ | 23.8 | 23.8 | | | 71.5 | 71.5 | | |
| DIST. | | -7.6 | -16.2 | -12.1 | -17.1 | | -42.3 | |
| CO. | -3.8 | | -6.0 | -8.1 | | -8.6 | -21.2 | |
| DIST. | | 1.9 | 4.1 | 5.0 | 7.0 | | 17.3 | |
| CO | 1.0 | | 2.5 | 2.0 | | 3.5 | 8.6 | |
| DIST. | | -0.8 | -1.7 | -1.8 | -2.5 | | -6.3 | |
| CO | -.4 | | -0.9 | -0.9 | | -1.3 | -3.1 | |
| DIST | | 0.3 | 0.6 | 0.7 | 1.0 | | 2.3 | |
| | 20.6 | 17.6 | -17.6 | -15.2 | 59.9 | 65.1 | -44.7 | |

$$P_{AB} = \frac{20.6 + 17.6}{9} = 4.24 \times 10^3$$

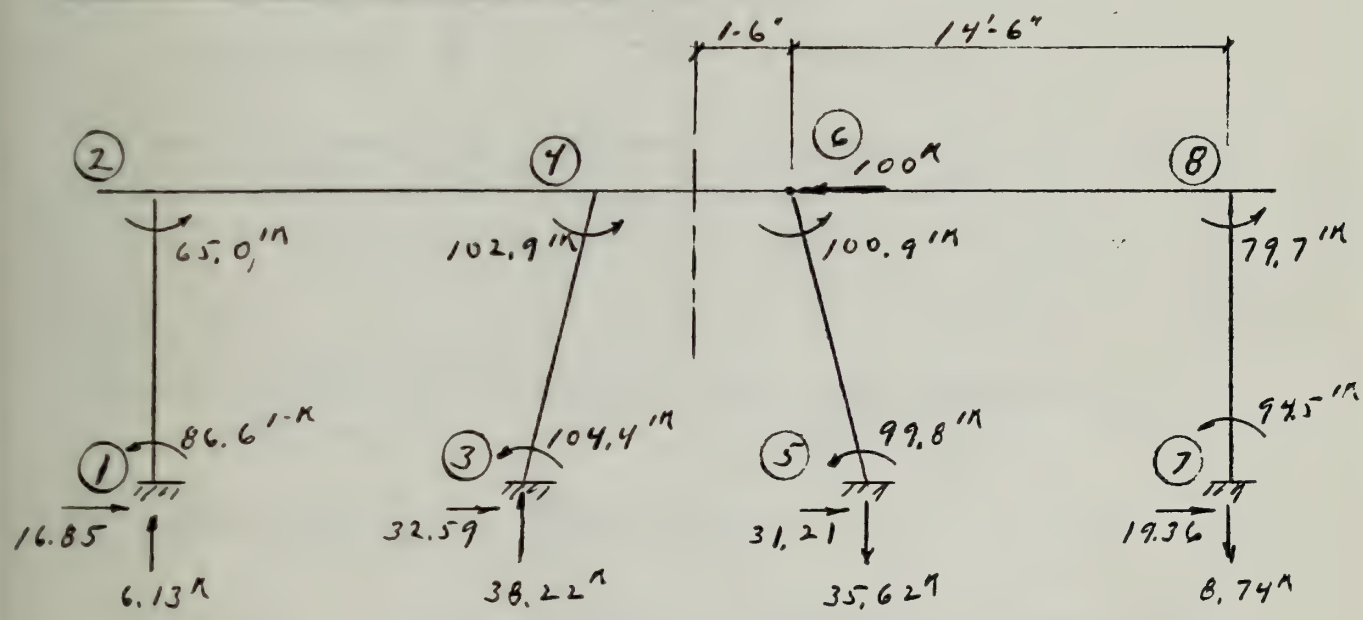
$$P_{CD} = \frac{65.1 + 59.9}{9} = 13.89 \times 10^3$$

$$K = \Sigma P = 2(4.24 + 13.89) \times 10^3 = 36.2 \times 10^3 \ K$$

DETERMINE TRANSVERSE BENT MOMENTS

REF.: FRAME 2C ANALYSIS - 10-11-84

LOADING: 100K TO LEFT AT NODE 6




| JOINT | BENT 2 V=331 | BENT 3 V=198 | BENT 4 V=147 | BENT 5 V=236 |
|---|---|---|---|---|
| 1-2 | 287 | 171 | 127 | 204 |
| 2-1 | 215 | 129 | 96 | 153 |
| 3-4 | 346 | 207 | 153 | 246 |
| 4-3 | 341 | 204 | 151 | 243 |
| 5-6 | 330 | 198 | 147 | 235 |
| 6-5 | 334 | 200 | 148 | 238 |
| 7-8 | 313 | 187 | 139 | 223 |
| 8-7 | 249 | 158 | 117 | 188 |

MOMENTS IN TRANSVERSE BENTS

NOTE: BENT SHEARS ARE TAKEN FROM SEISAB RUN 10-19-84 "MARKET ST. VIADUCT #1 PINNED LONGITUDINAL AT END".

ANTICIPATED BEHAVIOR OF COLUMNS

BENTS 3 & 4, AT ASSUMED POINT OF FIXITY:
$M_n = 526$ 'K

REQUIRED 'Z' = $\frac{526}{175} = 3.0$

BENTS HAVE MULTIPLE COLUMNS
COLUMNS HAVE SPIRAL REFORCEMENT.
∴ MAXIMUM 'Z' = 8.0

BENTS 3 & 4, AT COLUMN CAP CONNECTION.
$M_n = 425$

REQUIRED 'Z' = $\frac{425}{175} = 2.4$

PROBLEM: COLUMN-CAP CONNECTION IS UNCONFINED IN LONGITUDINAL DIRECTION, THEREFORE 'Z' SHOULD NOT EXCEED 1.0

IF CONNECTION FAILS, OPTIONAL FORCE PATHS EXIST.

1) MOMENT REDISTRIBUTES TO POINT OF FIXITY.

REVISED MOMENT = $526 + \frac{425}{2} = 738$ 'K

REQUIRED Z = $\frac{738}{175} = 4.2 < 8.0$

2) DISPLACEMENT WILL BE LIMITED BY SOIL AROUND COLUMNS.

COLUMN MOMENTS DUE TO LONGITUDINAL EARTHQUAKE.

VALUES TAKEN DIRECTLY FROM SEISAB RUN 10-19-84

| JOINT | BENT 2 | BENT 3 | BENT 4 | BENT 5 |
|---|---|---|---|---|
| 1-2 | 314 | 526 | 521 | 314 |
| 2-1 | 0 | 425 | 415 | 0 |
| 3-4 | 314 | 526 | 521 | 314 |
| 4-3 | 0 | 425 | 415 | 0 |
| 5-6 | 314 | 526 | 521 | 314 |
| 6-5 | 0 | 425 | 415 | 0 |
| 7-8 | 314 | 526 | 521 | 314 |
| 8-7 | 0 | 425 | 415 | 0 |

LOAD COMBINATIONS:

1.0 LONG. + 0.3 TRANSV.

0.3 LONG. + 1.0 TRANSV.

INSPECTION OF THE SEISAB PRINTOUT SHOWS THAT LONGITUDINAL FORCES CREATE VERY SMALL TRANSVERSE MOMENTS. TRANSVERSE FORCES CREATE VERY SMALL LONGITUDINAL MOMENTS.

VERTICAL D.L. = $4.4^{K/FT} \times \frac{17.5}{2} = 38^{K}$

NET AXIAL LOAD IN COLUMN 5-6 $\approx 0^{K}$

FROM INTERACTION TABLE, $M_n = 195^{K\text{-}FT}$ $(\phi = 1.0)$

UNFACTORED DESIGN CAPACITY = $\phi M_n$

COLUMN HAS NO AXIAL LOAD: $\therefore \phi = 0.90$

CAPACITY $M = 0.9 \times 195 = 175^{FK}$

ANTICIPATED BEHAVIOR OF EXPANSION JOINTS

COMPUTED DISPLACEMENTS OF JOINTS
FROM SEISAB 10-19-84

LONGITUDINAL: 0.052' x 12 = 0.62 INCHES

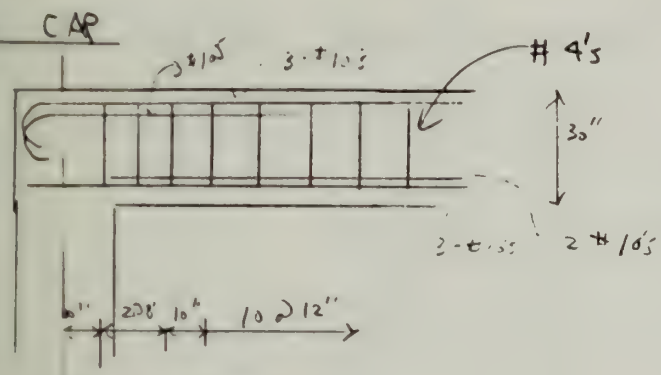
TRANSVERSE (WITHOUT RESTRAINTS)
15' CANTILEVER: 0.025 x 12 = 0.30 INCHES
5' CANTILEVER: 0.016 x 12 = 0.19 INCHES

POTENTIAL DIFFERENTIAL TRANSVERSE DISPLACEMENT
= 0.30 + 0.19 = 0.49 INCHES.

COMMENT
LONGITUDINAL BEARING WIDTH IS 11 INCHES.
∴ LONGITUDINAL DISPLACEMENT IS ACCEPTABLE

TRANSVERSE BEARING IS CONTINUOUS. A 2" DEEP BY 3 FOOT LONG KEYWAY WILL OFFER SOME RESTRAINT. IT IS ANTICIPATED THAT THE KEYWAY WILL BE DAMAGED AND MAY BE INEFFECTIVE, BUT OVERALL STRUCTURAL STABILITY WILL NOT BE IMPAIRED.

BENT CAP




VERTICAL SHEAR

$$V_s = \frac{A_v f_y d}{s} = \frac{0.2(2)(40)(26)}{8} = 52.0^{\text{kips}}$$

$$V_c = 2\sqrt{2500}\,(24)(26) = 62.4^{\text{kips}}$$

$$V_n = 0.85\,(52.0 + 62.4) = 97.2^{k}$$

SHEAR FRICTION

ASSUME ALL TENSION STEEL FOR NEGATIVE BENDING MOMENT IS BEING USED. ASSUME A TENSION ON THE CAP EQUAL TO ½ THE LENGTH BETWEEN THE 2 INTERIOR PILES TIMES THE TRIBUTARY WIDTH TIMES ACCELERATION

$$P_T = (8.51^{k})\left(\tfrac{1}{2}\right)\left(\tfrac{4}{40}\right)(25')(1.4g)$$
$$= 15^{k}$$

$$V_{SF} = \left(5(1.27\,in^2)(40\,ksi) - 15\right)(1.4)(.85) = 284^{k}$$

$$V_{n_{TOTAL}} = 284 + 97 = 381^{k}$$

$$V_{MAX} = 166^{k} < 381 \quad \text{o.k.}$$

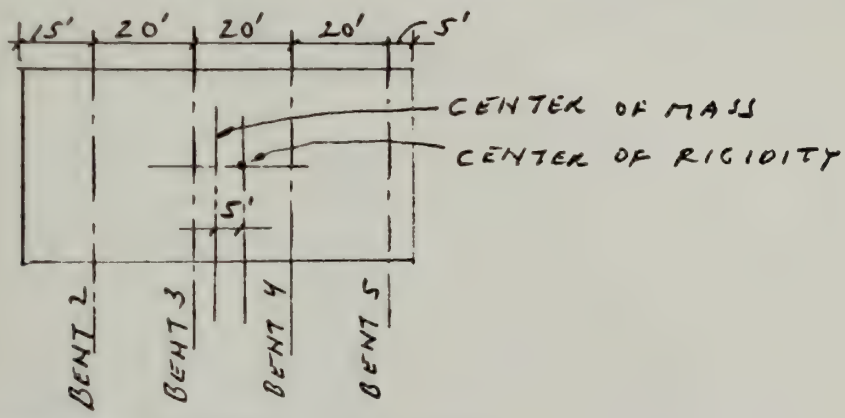
BENDING MOMENT

$$a = \frac{A_s f_y}{.85 f'_c b} = \frac{6.35(40)}{.85(2.5)(24)} = 5.0''$$

$$M'_n = 0.9(6.35)(40)\left(26.375 - \frac{5}{2}\right) = 455 \text{ ft-k}$$

$$M_{MAX} = 267 < 455 \quad \text{o.k.}$$

COMPARE CENTER SEGMENT WITH COMPUTER MODEL.



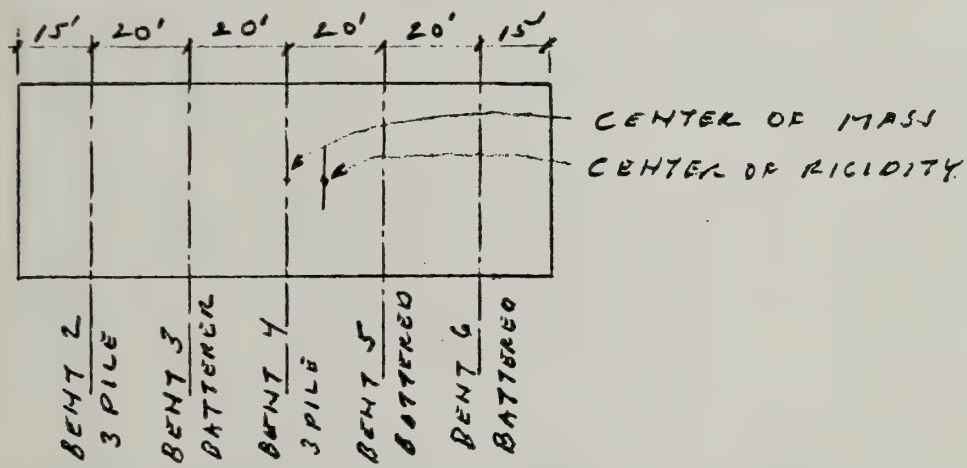

COMPUTER MODEL - 4 BENTS - TWO BATTER PILES PER BENT.

BATTER PILES ARE ASSUMED TO HAVE THREE TIMES THE STIFFNESS OF A VERTICAL PILE.

RELATIVE STIFFNESS:

3 PILE BENT = 3

BATTER PILE BENT: 2 + 3x2 = 8




CENTER SEGMENT - VIADUCT #4

COMPARE CENTER SEGMENT WITH COMPUTER MODEL.

LOCATE CENTER OF RIGIDITY

| BENT | K | x | Kx |
|---|---|---|---|
| 2 | 3 | -40 | -120 |
| 3 | 8 | -20 | -160 |
| 4 | 3 | 0 | 0 |
| 5 | 8 | +20 | +160 |
| 6 | 8 | +40 | +320 |
| | $\Sigma K = 30$ | | $\Sigma Kx = +200$ |

$\therefore x = \frac{200}{30} = 6.7'$ FROM BENT 4

RELATIVE STIFFNESS:

COMPUTER MODEL: $4 \times 8 = 32$

CENTER SEGMENT $2 \times 3 + 3 \times 8 = 30$

RELATIVE ROTATIONAL INERTIA:

COMPUTER MODEL: $2 \times 8 \times (30)^2 + 2 \times 8 \times (10)^2 = 16{,}000$

CENTER SEGMENT.

$$3 \times (46.7)^2 + 8 \times (26.7)^2 + 3 \times (6.7)^2 + 8 \times (13.3)^2 + 8 \times (33.3)^2 = 22670$$

RELATIVE ECCENTRIC MOMENT

COMPUTER MODEL: $80 \times 5 = 400$

CENTER SEGMENT $100 \times 6.7 = 600.7$

RELATIVE TRANSLATION:

$$\Delta = \frac{\text{MASS (SEGMENT)}}{\text{MASS (MODEL)}} \times \frac{\text{STIFFNESS (MODEL)}}{\text{STIFFNESS (SEGMENT)}} = \frac{100}{80} \times \frac{32}{30} = 1.33$$

RELATIVE ROTATION

$$\theta = \frac{\text{MOMENT (SEGMENT)}}{\text{MOMENT (MODEL)}} \times \frac{\text{INERTIA (MODEL)}}{\text{INERTIA (SEGMENT)}} = \frac{600.7}{400} \times \frac{16000}{22670} = 1.06$$

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

| | | | |
|---|---|---|---|
| 2439 | JOB SF BRIDGES | BY GLM | DATE [illegible] |
| | SUBJECT MARKET ST. VIADUCT #3 | CHK'D | DATE |

SHEET NO.

SAN FRANCISCO BRIDGES

SEISMIC RESISTANCE

MARKET STREET SIDEHILL VIADUCT #3

HATTIE ST TO CORBETT AVE

NOVEMBER 14, 1984

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STRUCTURAL ASSUMPTIONS

1) THE HEIGHT OF THE VARIOUS COLUMNS ARE NOT GIVEN IN THE DRAWINGS. THE HEIGHT OF ALL 3 COLUMNS IN A SINGLE BENT WILL BE ASSUMED THE SAME HEIGHT AND DECK ELEVATION. THE HEIGHTS AND DECK ELEVATIONS WILL BE SCALED FROM THE LONGITUDINAL SECTION IN THE DRAWINGS. THE BOTTOM OF THE COLUMN WILL BE ASSUMED TO BE LOCATED AT THE MIDDLE OF THE LONGITUDINAL STRUTS BELOW GRADE. AT THIS LOCATION THE COLUMN WILL BE ASSUMED TO BE PERFECTLY FIXED.
2) IF PLASTIC HINGING IS TO OCCUR, IT WILL BE LOCATED AT THE FIXED LOCATION BELOW GRADE AND AT THE BOTTOM OF THE BENT CAP IN THE TRANSVERSE DIRECTION AND THE CENTROID OF THE BRIDGE DECK IN THE LONGITUDINAL DIRECTION.
3) THE TRANSVERSE SHEAR KEYS AT THE HINGES IN THE DECK ARE TOO SMALL TO CARRY ANY APPECIABLE LATERAL LOAD.

COMPUTER MODEL

THE BRIDGE IS MADE UP OF A NUMBER OF 80' TO 100' SECTIONS SEPERATED BY VERTICAL HINGES (THE HINGES CARRY ONLY VERTICAL LOAD AND NO MOMENTS). AN EXPANSION JOINT OF 1" EXISTS AT EACH HINGE. FOR THIS REASON THE BRIDGE WILL BE IDEALIZED AS A NUMBER OF INDEPENDENT SECTIONS DIVIDED BY THE HINGES. THE MOST CRITICAL CASE OCCURS IN THE SECTION WHERE THE COLUMNS ARE THE TALLEST, ESPECIALLY WHEN THE HEIGHTS OF THE COLUMNS DIFFER BY A GREAT DEAL. THE REASON FOR THIS IS THAT WITH A LARGE DIFFERENCE IN THE COLUMN HEIGHTS, THE COLUMNS AT ONE END OF THE SECTION WILL BE VERY STIFF COMPARED TO THOSE AT THE OTHER END. SO FOR A LOADING TRANSVERSE TO THE BRIDGE DECK A LARGE TORSIONAL LOAD WILL DEVELOP. THIS WILL CAUSE THE SHORTER COLUMNS TO ABSORB A VERY HIGH LOAD WHILE THE TALL COLUMNS CARRY VERY LITTLE.

THE MOST CRITICAL SECTION IS AT THE CENTER OF THE BRIDGE WITH COLUMNS RANGING IN HEIGHT FROM 10' TO 25'. THE TOTAL LENGTH OF THE MODELED SECTION IS 100'. THE BENTS ARE SPACED 20' APART, BEFORE THE FIRST BENT IS AN OVERHANG OF 15' AND AFTER THE LAST BENT IS AN OVERHANG OF 5'.

BOUNDARY CONDITIONS

THE VERY ENDS OF THE BRIDGE SECTION ARE MODELED AS ABUTMENTS CARRYING ONLY VERTICAL LOADS. IN REALITY THEY WOULD NOT BE THAT STIFF, BUT FOR PURPOSES OF THIS ANALYSIS THE GENERAL RESULTS WILL BE ADEQUATE.

COMPUTER MODEL, CONT.

BOUNDARY CONDITIONS

THE COLUMNS AT THE ENDS OF THE SECTION, BENTS 2 & 6, ARE MODELED AS PINNED AT THE TOP OF THE COLUMNS IN THE LONGITUDINAL DIRECTION OF THE BRIDGE DECK. ALL OTHER COLUMN CONNECTIONS ARE ASSUMED TO BE FIXED. THE DEPTH OF FIXITY OF THE COLUMNS BELOW GRADE IS ASSUMED TO BE LOCATED AT THE CENTERLINE OF THE LONGITUDINAL RUNNING STRUTS. THE HEIGHT OF ALL COLUMNS IN A SINGLE BENT ARE ASSUMED TO BE OF EQUAL HEIGHT, SCALED FROM THE DRAWING PROFILE. THE REASONS FOR THIS IS THAT THE COMPUTER PROGRAM WILL NOT ACCEPT MORE THAN ONE HEIGHT AND THERE IS NO FURTHER INFORMATION ABOUT THE ACTUAL COLUMN HEIGHTS.

ELEMENTS

EACH COLUMN IS MODELED AS TWO ELEMENTS OF EQUAL LENGTH. DUE TO THE ANTICIPATED HIGH STRESSES IN THE COLUMNS, THE COLUMNS WILL BE ASSUMED TO BE CRACKED. THEREFORE, THE MOMENTS OF INERTIA OF THE GROSS SECTION WILL BE REDUCED BY 1/2 TO ACCOUNT FOR CRACKING.

EACH BENT CAP IS MODELED AS TWO ELEMENTS. ONE ELEMENT BETWEEN THE CENTER COLUMN AND EACH OUTER COLUMN. SINCE CRACKING IS NOT ANTICIPATED IN THE BENT CAPS, FULL GROSS SECTION PROPERTIES WILL BE USED.

THE BRIDGE DECK IS MODELED AS 6 SPANS, EACH SPAN CONSISTS OF 4 EQUAL LENGTH ELEMENTS. SINCE CRACKING OF THE DECK IS NOT ANTICIPATED FULL GROSS SECTION PROPERTIES WILL BE USED.

THE SECTION PROPERTIES ARE SHOWN IN THE CALCULATION [illegible] VIADUCT #1.

COMPUTER MODEL, CONT.

LOADING

THE WEIGHT OF THE DECK AND BENT CAPS WILL BE APPLIED AS A UNIFORM LOAD ACCROSS THE DECK. THE COLUMN WEIGHTS WILL BE UNIFORMLY DISTRIBUTED THROUGHOUT THEIR HEIGHTS.

THE SEISMIC LOAD WILL CONSIST OF THE RECOMMENDED CALTRANS RESPONSE SPECTRUM CURVE FOR A ZPA OF 0.5g WITH THE DEPTH TO BEDROCK LOCATED AT 10' TO 50'. THE DAMPING VALUE USED IS 5% OF CRITICAL.

S/BLUME

Bsie Street (at New Montgomery)

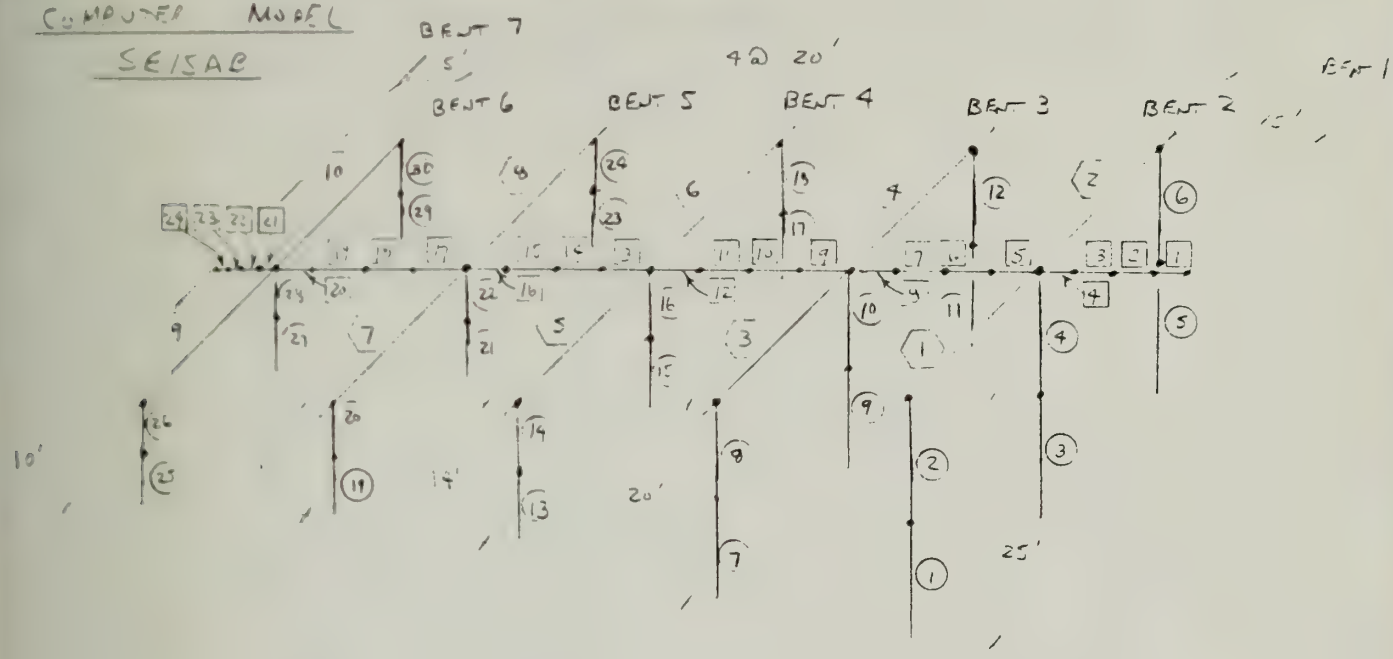
Fancisco, California 94105

| | | | |
|---|---|---|---|
| 9430 | JOB SF BRIDGES | BY G.M | DATE |
| | SUBJECT MARKET ST. VIADUCT #3 | CHK'D | DATE |

SHEET NO. 3

COMPUTER MODEL

SEISAB

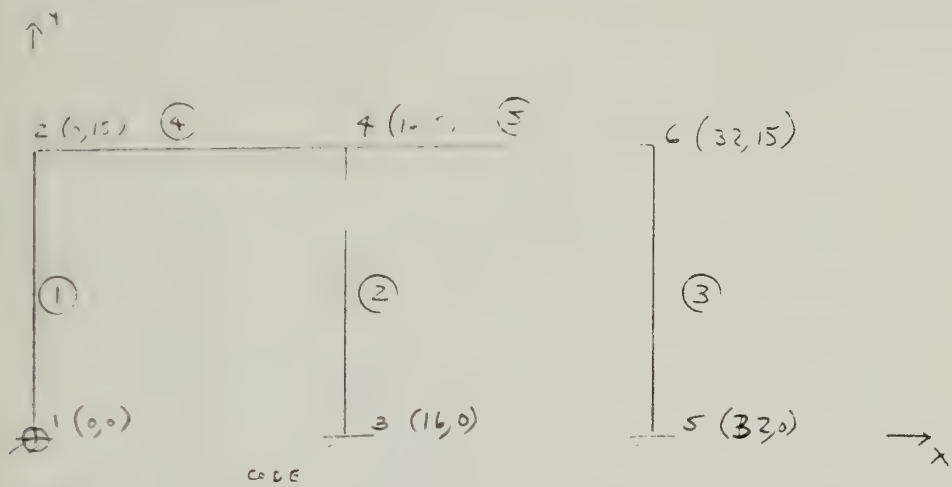



□ - SPAN ELEMENTS

○ - BENT COLUMN ELEMENTS

⬡ - BENT CAP ELEMENTS

FRAME 2C MODEL (DEAD LOAD)
1 BENT OF BRIDGE




| | | CODE |
|---|---|---|
| JOINTS 1, 3, 5 | - | 111 |
| JOINTS 2, 4, 6 | - | 000 |

$E = 410,400$

BEAMS 4, 5 - $A = 5.0$, $I = 2.6$
BEAMS 1, 2, 3 - $A = 3.14$, $I = 0.785$

LOAD

BEAMS - $w = \frac{0.69\ k/ft}{4\ ft}(20') = 4.14\ k/ft$
COLUMNS - $P = 3.14(.15)(15') = 7.07\ k/col.$

FIXED END FORCES

BEAMS 4, 5

$V = \frac{wl}{2} = \frac{4.14(16)}{2} = 33.12$

$M = \frac{wl^2}{12} = \frac{4.14(16)^2}{12} = 88.32$

JOINT FORCES

JOINT 4 : $P_y = -7.07$

JOINT 2 : $P_y = -7.07 - 4.14(5) = -27.77$

$M_y = \frac{4.14(5)^2}{2} = +51.75$

JOINT 6 : $P_y = -27.77$

$M_y = -51.75$

FRAME 2C

[illegible] PROJECT #

| | | |
|---|---|---|
| [illegible] ELEMENTS | = | 5 |
| [illegible] NODAL POINTS | = | 6 |
| [illegible] MATERIALS | = | 1 |
| [illegible] ELEMENT TYPES | = | 2 |
| [illegible] ELASTIC SUPPORT TYPES | = | 0 |
| [illegible] FIXED END FORCE TYPES | = | 1 |
| [illegible] JOINT FORCE TYPES | = | 4 |

| YOUNG'S MODULUS | POISSON'S RATIO |
|---|---|
| [illegible] | [illegible] |

| AXIAL AREA | SHEAR AREA | MOMENT OF INERTIA |
|---|---|---|
| 3.140 | .000 | .785 |
| [illegible] | .000 | [illegible] |

FIXED END FORCES IN LOCAL COORDINATES

| AXIAL I | SHEAR I | MOMENT I | AXIAL J | SHEAR J | MOMENT J |
|---|---|---|---|---|---|
| .000 | 33.120 | 88.320 | .000 | 33.120 | -88.320 |

[illegible]FORCE CARDS

| X | Y | R |
|---|---|---|
| .000 | -27.770 | 51.750 |
| .000 | -7.070 | .000 |
| .000 | -27.770 | -51.750 |
| 100.000 | .000 | .000 |

| | NODAL COORDINATES | | BOUNDARY CONDITIONS | | ELASTIC SUPPORT | |
|---|---|---|---|---|---|---|
| CODE | X | Y | X | Y | Z | TYPE |
| [illegible]11 | .000 | .000 | .000 | .000 | .000 | 0 |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | .000 | 15.000 | .000 | -27.770 | 51.750 | 0 |
| | | | .000 | .000 | .000 | |

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

| [illegible] | [illegible] | MATERIAL INDEX | ELEMENT TYPE | ELEMENT CODE | FIXED END FORCE TYPE | STIFFNESS [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | 1 | 1 | 0 | 0<br>0<br>0 | 4.0 | 4.0 | [illegible] |
| [illegible] | 4 | 1 | 1 | 0 | 0<br>0<br>0 | 4.0 | 4.0 | .5 |
| [illegible] | 6 | 1 | 1 | 0 | 0<br>0<br>0 | 4.0 | 4.0 | .5 |
| [illegible] | 4 | 1 | 2 | 0 | 1<br>0<br>0 | 4.0 | 4.0 | .5 |
| 4 | 6 | 1 | 2 | 0 | 1<br>0<br>0 | 4.0 | 4.0 | .5 |

| [illegible]-DISPLACEMENT | Y-DISPLACEMENT | Z-ROTATION |
|---|---|---|
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00001 | -.00068 | -.00012 |
| .03325 | .00026 | -.00077 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | -.00091 | .00000 |
| .03350 | .00000 | -.00015 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |

| | | |
|---|---|---|
| .00001 | -.00065 | .0001 |
| [illegible] | [illegible] | [illegible] |
| .00000 | .00000 | .00000 |

MEMBER END FORCES

| AXIAL I | SHEAR I | MOMENT I | AXIAL J | SHEAR J | MOMENT J |
|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | 1.020 | [illegible] |
| [illegible] | 31.474 | 252.603 | 22.300 | -31.474 | 219.514 |
| .000 | .000 | .000 | .000 | .000 | .000 |
| [illegible] | .000 | .000 | [illegible] | .000 | [illegible] |
| .000 | 37.052 | 281.191 | [illegible] | -37.052 | [illegible] |
| .000 | [illegible] | .000 | [illegible] | .000 | .000 |
| [illegible] | 1.020 | [illegible] | [illegible] | -1.020 | [illegible] |
| [illegible] | 31.474 | [illegible] | [illegible] | -31.474 | [illegible] |
| .000 | .000 | .000 | .000 | .000 | .000 |
| 1.020 | 30.826 | 61.976 | -1.020 | 35.414 | [illegible] |
| 1.474 | -22.300 | -219.514 | 31.474 | 22.300 | -137.191 |
| .000 | .000 | .000 | .000 | .000 | .000 |
| 1.020 | 35.414 | 98.683 | -1.020 | 30.826 | -61.976 |
| 1.474 | -22.300 | -137.191 | -31.474 | 22.300 | -219.514 |
| .000 | .000 | .000 | .000 | .000 | .000 |

APPLIED JOINT LOADS AND REACTIONS

| FORCE X | FORCE Y | MOMENT Z |
|---|---|---|
| 1.020 | 58.596 | -5.079 |
| -31.474 | -22.300 | 252.603 |
| .000 | .000 | .000 |
| .000 | -27.770 | 51.750 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | 77.898 | .000 |
| -37.052 | .000 | 281.191 |
| .000 | .000 | .000 |
| .000 | -7.070 | .000 |
| 100.000 | .000 | .000 |
| .000 | .000 | .000 |
| -1.020 | 58.596 | 5.079 |
| -31.474 | 22.300 | 252.603 |
| .000 | .000 | .000 |
| .000 | -27.770 | -51.750 |
| .000 | .000 | .000 |
| .000 | .000 | .000 |

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

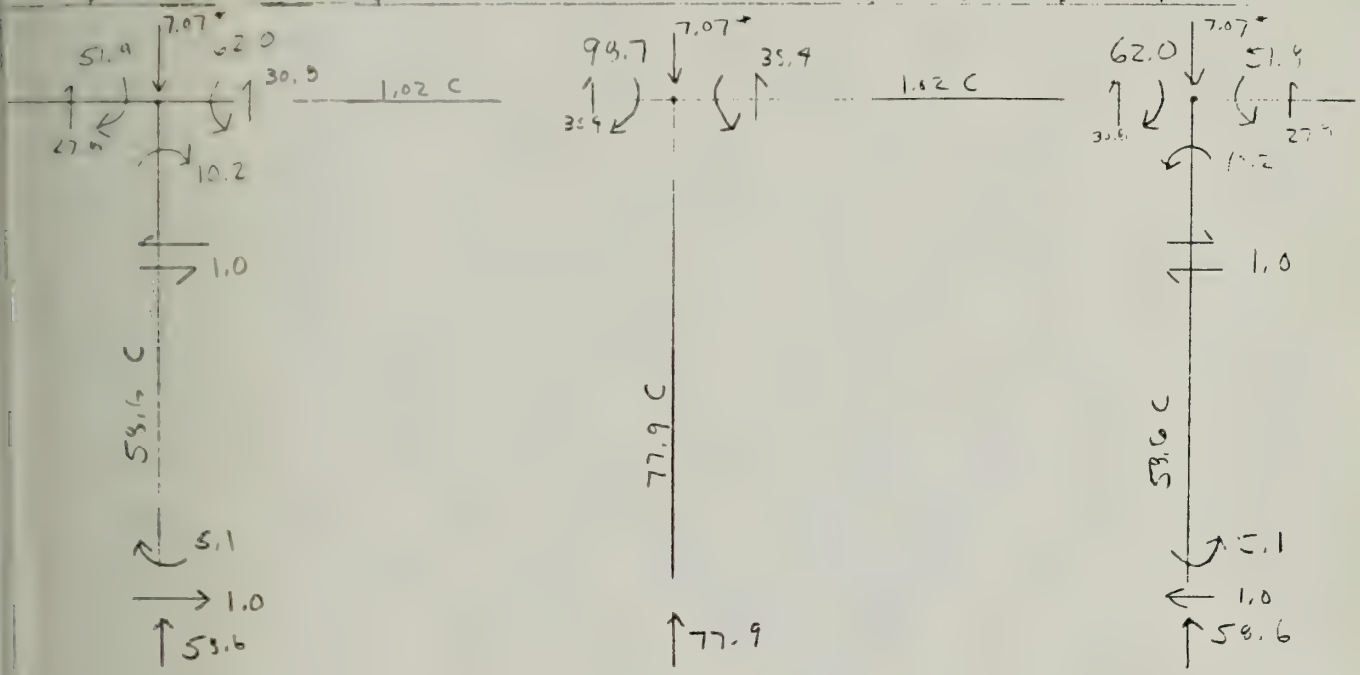
SHEET NO. 13

JOB S F BRIDGES BY GSM DATE 10/23

SUBJECT MARKET ST. VIADUCT #2 CHK'D DATE

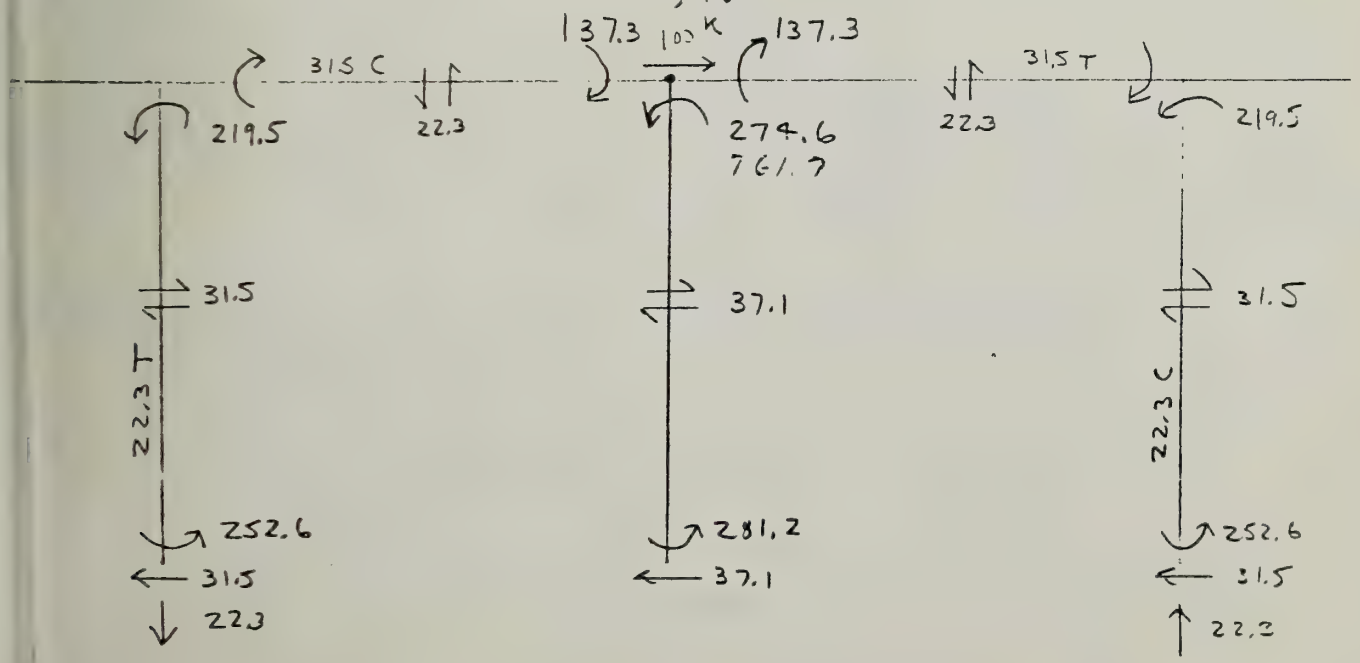
FRAME 2C (DEAD LOAD) 15' COLUMNS

w = 4.14 K/L [20' TRIBS AT WIDTH], X 42' = 174 K




* DEAD LOAD OF COLUMNS IS APPLIED AT TOP OF COLUMNS

LATERAL LOAD 15' COLUMN, 78"



MODAL RESPONSE

IN A RESPONSE SPECTRUM ANALYSIS EACH MODE INCREASES THE TOTAL RESPONSE OF THE STRUCTURE. TO OBTAIN AN ACCURATE REPRESENTATION OF THE STRUCTURAL RESPONSE ENOUGH MODES MUST BE USED SUCH THAT ANY RESPONSE DUE TO ADDITIONAL MODES WILL BE NEGLIGIBLE. SINCE THE MODES ARE COMBINED ON AN SRSS BASIS (ACTUALLY CQC - BUT FOR NON-CLOSELY SPACED MODES IT BECOMES SRSS) THE MODES WITH HIGH PARTICIPATION FACTOR WILL CONTRIBUTE VIRTUALLY ALL OF THE RESPONSE. IF ALL MODES OF THE STRUCTURE WERE FOUND, THE SUM OF THE PARTICIPATION FACTORS SQUARED WOULD BE EQUAL TO THE TOTAL STRUCTURAL MASS. THE PARTICIPATION FACTOR SQUARED FOR A PARTICULAR MODE IS THE EFFECTIVE MODAL MASS. IF THE CUMULATIVE EFFECTIVE MODAL MASS FOR A NUMBER OF MODES IS CLOSE TO THE TOTAL STRUCTURAL MASS, THEN THE MODES USED IS ACCURATE ENOUGH TO CAPTURE THE RESPONSE OF THE STRUCTURE.

STRUCTURAL MASS

DECK $9.69^{k/'} \times 100' =$ $969^k \div 32.2 = 26.99$

COLUMNS $(3)(3.14)(3/4)(.15)(25+20+14+11+10) =$ $85^k \div 32.2 = 2.63$

TOTAL $= 954^k \div 32.2 = 29.62 \frac{k\text{-sec}^2}{\text{ft}}$

| MODE | DIRECTION | $\Gamma$ | $(\Gamma)^2$ | $\Sigma \Gamma_L^2$ | % $M_L$ | $\Sigma \Gamma_T^2$ | % $M_T$ |
|---|---|---|---|---|---|---|---|
| 1 | TRANSVERSE | 4.298 | 18.39 | | | 18.39 | 62.1 |
| 2 | LONGIT. | 5.381 | 28.96 | 28.96 | 97.8 | | |
| 3 | TRANS. | 3.284 | 10.78 | | | 29.17 | 98.5 |

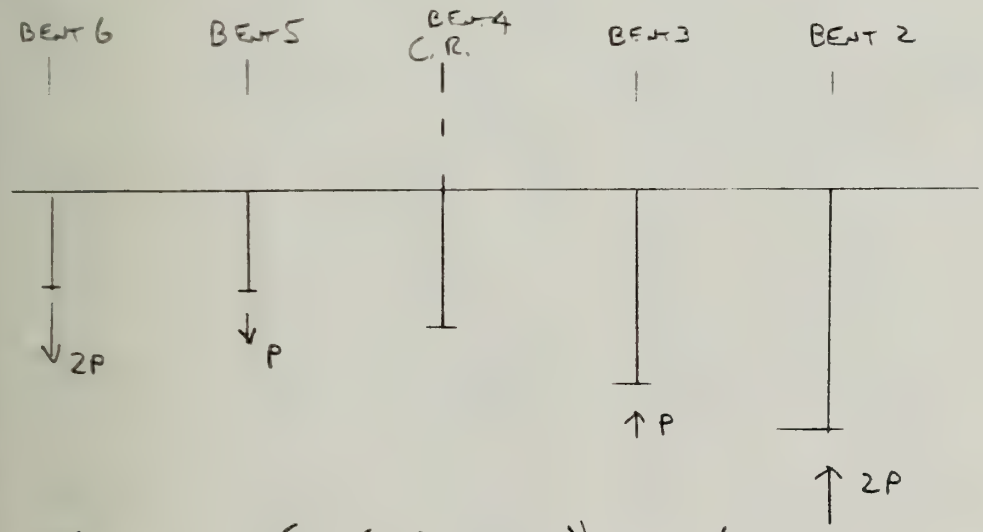
REF: GLMS15AB2P3.OUT 10/15/94

SINCE 98% OF THE MASS IS EFFECTIVE IN EACH DIRECTION, THE NUMBER OF MODES USED IS ADEQUATE

AXIAL LOAD -

THE COMPUTER MODEL USES COLUMNS OF VARYING LENGTHS FOR THE DIFFERENT COLUMN BENTS. THIS IS FAIRLY ACCURATE FOR OBTAINING THE BENDING MOMENTS AND COLUMN SHEARS, HOWEVER, FOR AXIAL LOADS, THE COLUMN STIFFNESSES SHOULD BE FAIRLY SIMILAR. THIS IS TRUE SINCE ALL THE PILES ARE NEARLY THE SAME LENGTH, AND THE ARE PROBABLY EMBEDDED IN BEDROCK.

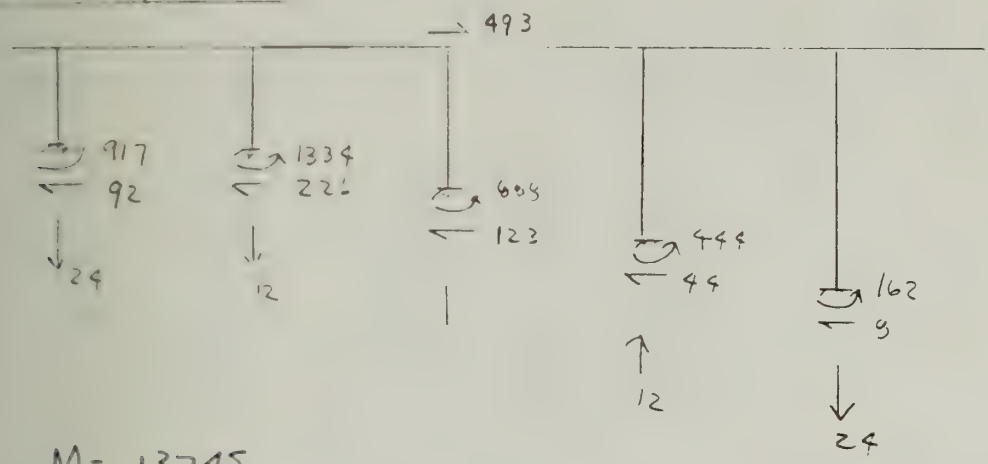
SINCE ALL BENTS HAVE EQUAL VERTICAL STIFFNESS, ASSUME THAT THE CENTER OF RIGIDITY IS AT THE MIDDLE BENT AND THE LOADS IN THE BENTS ARE PROPORTIONAL TO THE DISTANCE FROM THE MIDDLE BENT, SO THE DISTRIBUTION IS AS FOLLOWS:




$$M_{TOTAL} = 2(2P(40') + P(20')) = 200'P$$

$$P = \frac{M}{200'}$$

LONGITUDINAL LOAD

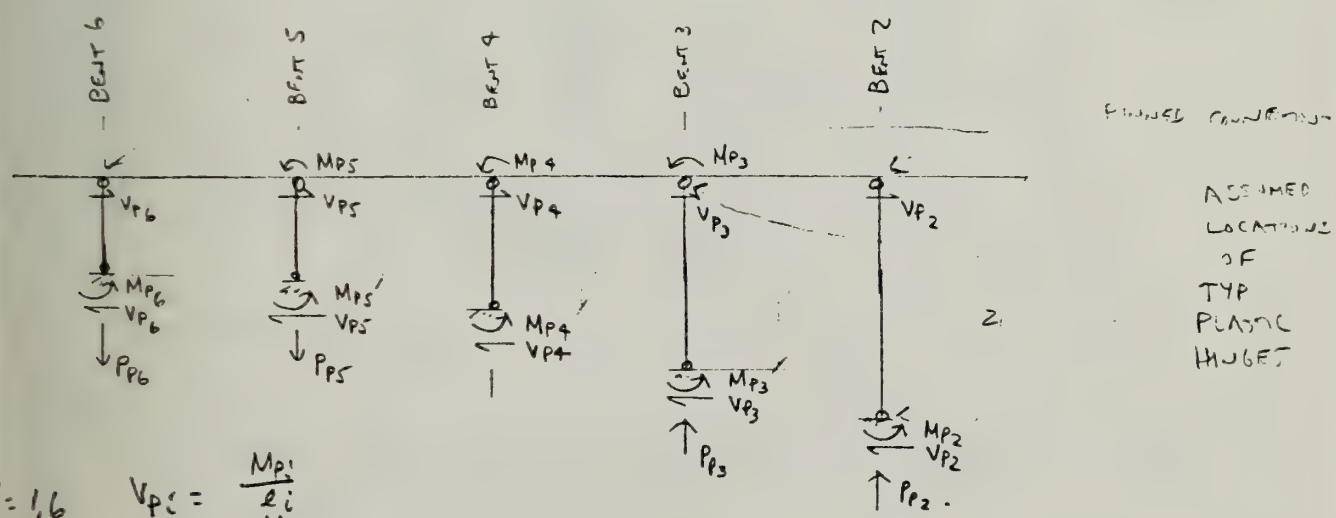



$M = +3745$

$V_h = -6208$

$P = \frac{6208 - 3745}{200} = 12^k$

THE MOMENTS AND SHEARS ABOVE ARE OBTAINED FROM THE COMPUTER RESULTS. THE AXIAL LOADS ARE OBTAINED AS SHOWN ON THE PREVIOUS SHEET




$i = 1,6 \quad V_{Pi} = \frac{M_{Pi}}{l_i}$

$= 3,4,5 \quad V_{Pi} = \frac{2 M_{Pi}}{l_i}$

$P_{P5} = P_{P3} = P, \quad P_{P6} = P_{P2} = 2P$

$$P = \left[\left(\sum_{2}^{i=6} V_{Pi} \times l_i\right) - \left(\sum_{2}^{i=6} M_{Pi}\right)\right] \div 200$$

/BLUME
sie Street (at New Montgomery)
ncisco, California 94105

SHEET NO. 17
JOB SF BRIDGES
BY G.M DATE
SUBJECT MARIN CO VIADUCT #3
CHK'D DATE

LONGITUDINAL SECTION - COLUMN LOADS

| JNT | AXIAL LOAD (1) | WIND (4) | $P_p$ | (2) $M_p$ | (3) $V_p$ | (5) $M'_u$ | (6) $M_{EXT}$ | $M_{EXT}/M'_u$ | $M_{EXT}/M'_u$ |
|---|---|---|---|---|---|---|---|---|---|
| 2 | -70 | -24 | -94 | 314 | 13 | | | | |
| 3 | -71 | -12 | -83 | 307 | 31 | | | | |
| 4 | -66 | 0 | -66 | 296 | 42 | | | | |
| 5 | -67 | +12 | -55 | 289 | 53 | | | | |
| 6 | -65 | +24 | -41 | 291 | 28 | | | | |
| | | | | 1497 | 167 | | | | |
| 2 | -70 | -8 | -79 | 304 | 12 | 186 | 186 | 1.0 | .13 |
| 3 | -71 | -4 | -75 | 302 | 30 | 196 | 514 | 2.9 | .35 |
| 4 | -66 | 0 | -66 | 296 | 42 | 195 | 1023 | 5.5 | .69 |
| 5 | -67 | +4 | -63 | 294 | 54 | 185 | 1556 | 8.4 | 1.05 |
| 6 | -65 | +8 | -57 | 291 | 29 | 185 | 1051 | 5.7 | .71 |
| | | | | 1497 | 167 | | | | |
| 2 | -70 | +8 | -62 | 294 | 12 | | | | |
| 3 | -71 | +4 | -67 | 297 | 30 | | | | |
| 4 | -66 | 0 | -66 | 296 | 42 | | | | |
| 5 | -67 | -4 | -71 | 299 | 54 | | | | |
| 6 | -65 | -8 | -73 | 301 | 30 | | | | |
| | | | | 1497 | 168 | | | | |

(1) REF. 1
(2) $M_p = 1.3 \times M_u$ ($M_u$ FROM INTERACTION DIAG. Sh. 22)
(3) SEE PREVIOUS SHEET
(4) SEE P ON PREVIOUS SHEET
(5) $M'_u = \phi M_u$ ; $\phi = 0.9$, $P = 0$ ; $\phi = 0.75$, $P \geq 113^k$ ; $\phi$ LINEAR INTERPOLATED $0 < P < 113$.
(6) REF 2

BLUME

e Street (at New Montgomery)
ncisco, California 94105

SHEET NO. 19

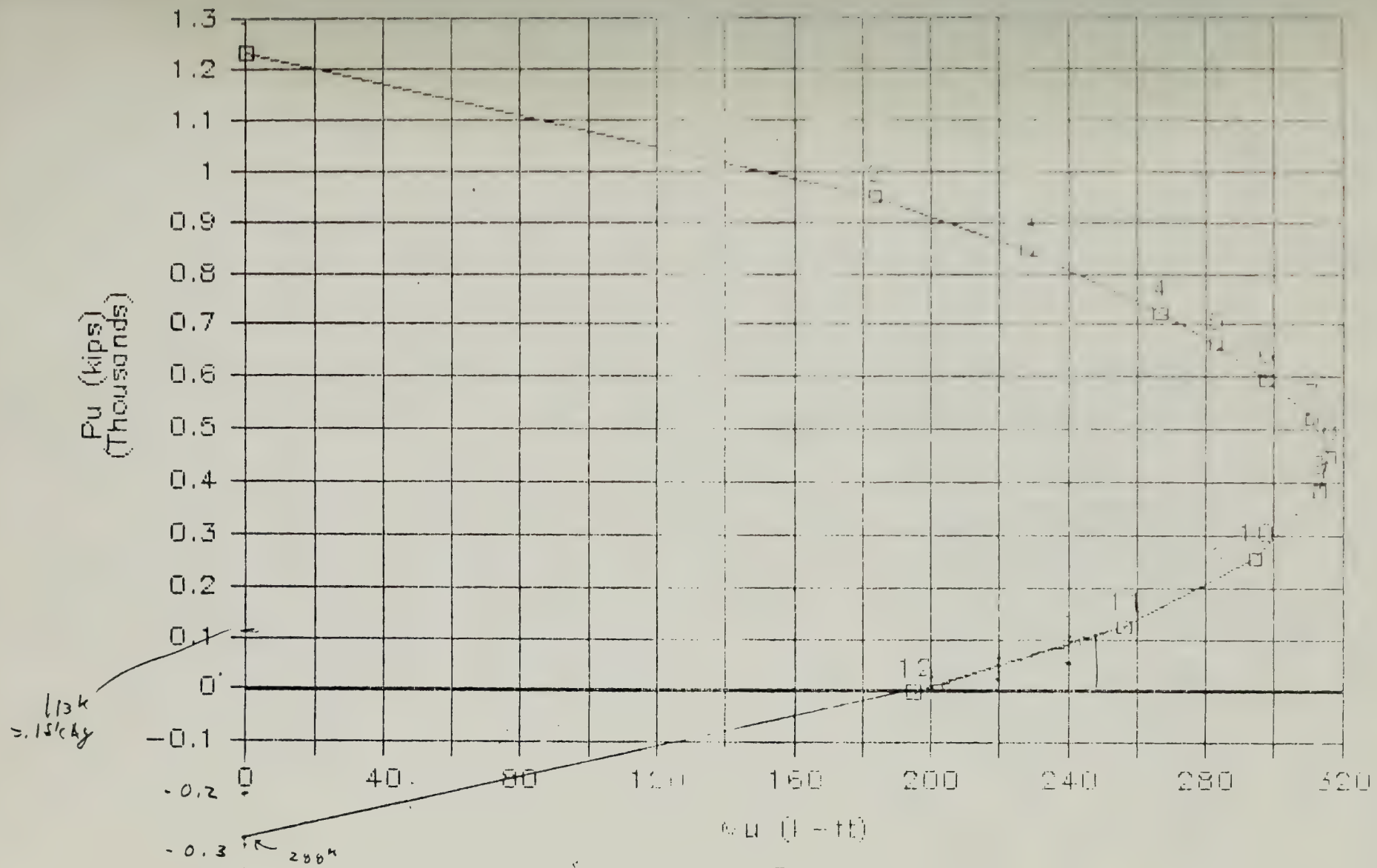
JOB OF BOLLET BY GLM DATE 11/1

SUBJECT MAGNET OF WINDOW #3 CHK'D DATE

WINDOW TRANSVERSE TO BRIDGE DECK.

THE COLUMNS WHICH ARE PINNED IN THE LONGITUDINAL DIRECTION HAVE REINFORCING AT THE CONNECTION FOR TRANSVERSE MOMENT WHICH DIFFERS FROM THE REMAINDER OF THE COLUMN. THE INTERACTION DIAGRAMS FROM THE 2 ARRANGEMENTS OF REINFORCING ARE VERY SIMILAR. SO FOR SIMPLICITY, THE CAPACITY AT THE PINNED CONNECTION WILL BE ASSUMED TO BE EQUAL TO THAT AT THE TYPICAL CROSS SECTION.

THE PAGES WHICH FOLLOW SHOW THE INTERACTION DIAGRAMS OBTAINED FROM THE COMPUTER PROGRAM 'CIRCCOL' LOCATED IN LOGIC 1-2-3 ON THE IBM PC.


Pu (kips)
(Thousands)
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
40
80
120
160
200
240
280
320
Mu (ft-lb)
113k
=.15fcAg
288k

[illegible] MARCH #3 GLM 10/3/84

Sh 2

READY

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Es= | ( | 29000 ) | | Dc= | ( | 24 ) | | as= | ( | 0.6 ) | | | CIRCCOL | | |
| fy= | ( | 40 ) | | Ds= | ( | 17 ) | | nb= | ( | 12 ) | | | | | |
| f c= | ( | 2.5 ) | | B1= | ( | 0.85 ) | | | | | | | | | |
| units : | | ksi | | Cb= | ( | 14.04 ) | | | | | | | | | |

COL: (24" PILE )

| point | Pu | Mu k-in | Mu k-ft | c | Note: |
|---|---|---|---|---|---|
| 1 | 1234.0 | 0.0 | 0.0 | | Dc: concrete sect dia |
| 2 | 951.1 | 2205.2 | 183.8 | 21.01 | Ds: reinf. ring dia |
| 3 | 845.3 | 2733.9 | 227.8 | 19.02 | as: single bar area |
| 4 | 725.2 | 3200.4 | 266.7 | 17.03 | nb: no. of bars |
| 5 | 663.3 | 3390.5 | 282.5 | 16.03 | 5 =< nb <= 19 |
| 6 | 595.4 | 3571.0 | 297.6 | 15.04 | |
| 7 | 522.6 | 3723.4 | 310.7 | 14.04 | |
| 8 | 450.5 | 3790.2 | 315.9 | 13.05 | press [PgDn] for |
| 9 | 386.4 | 3757.0 | 313.1 | 12.05 | factored loads |
| 10 | 256.7 | 3531.2 | 294.3 | 10.06 | |
| 11 | 124.9 | 3075.1 | 256.3 | 8.07 | press F5 HELP [ENTER] |
| 12 | -1.7 | 2339.5 | 195.0 | 6.08 | for help |

CAPS

SF BRIDGES MARKER #3 GLM 10/7/82

CIRCULAR

READY

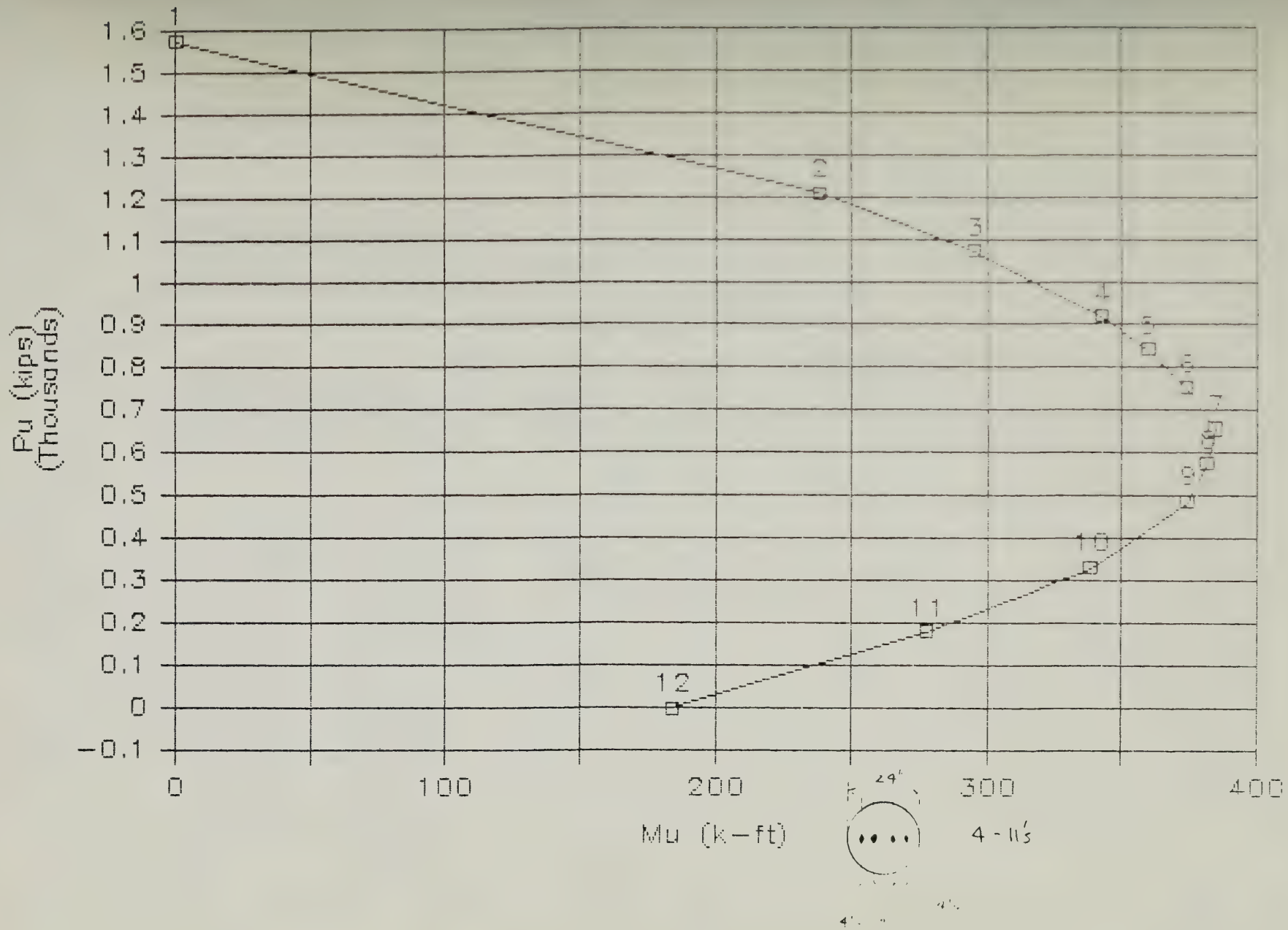
R S T U V W X Y Z AA AB AC AD AE

c= (14.04330)

| d1 | area | esi (c+,t-) | fsi (c+,t-) | Psi (c+,t-) | h/2-d1 | F*x |
|---|---|---|---|---|---|---|
| 3.5 | 0.6 | 0.002252 | 40 | 22.725 | 8.5 | 193.1625 |
| 38784 | 1.2 | 0.002009 | 40 | 45.45 | 7.361215 | 334.5672 |
| 7.75 | 1.2 | 0.001344 | 38.98780 | 44.23536 | 4.25 | 188.0003 |
| 12 | 1.2 | 0.000436 | 12.65853 | 12.64024 | -1.8E-15 | -2.2E-14 |
| 16.25 | 1.2 | -0.00047 | -13.6707 | -16.4048 | -4.25 | 69.72073 |
| 36121 | 1.2 | -0.00113 | -32.9450 | -39.5341 | -7.36121 | 291.0191 |
| 20.5 | 0.6 | -0.00137 | -40 | -24 | -8.5 | 204 |
| 0 | 0 | 0.003 | 40 | 0 | 12 | 0 |
| 0 | 0 | 0.003 | 40 | 0 | 12 | 0 |
| 0 | 0 | 0.003 | 40 | 0 | 12 | 0 |
| sum a = | 7.2 | | sum Psi | =45.11161 | sum F*x | =1280.469 |
| | | | .85f'cA | =477.4410 | .85f'cAx | =2447.898 |
| c | =7.134913 | | sum | =522.5526 | sum | =3728.368 |

CAPS

# Column Interaction Diagram



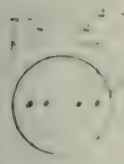
1.75 READY

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Es= | ( | 29000 ) | | Dc= | ( | 24 ) | | as= | ( | 1 ) | | | CIRCCOL | | |
| fy= | ( | 40 ) | | Ds= | ( | 19.75 ) | | nb= | ( | 10 ) | | | | | |
| f'c= | ( | 3.5 ) | | B1= | ( | 0.85 ) | | | | | | | | | |
| nits : | | ksi | | Cb= | ( | 13.53 ) | | | | | | | | | |

COL: (TITLE )

| pint | Pu | Mu k-in | Mu k-ft | c | Note: |
|---|---|---|---|---|---|
| 1 | 1576.9 | 0.0 | 0.0 | | Dc: concrete sect dia |
| 2 | 1212.6 | 2861.7 | 238.5 | 20.86 | Ds: reinf. ring dia |
| 3 | 1075.3 | 3540.6 | 295.1 | 18.76 | as: single bar area |
| 4 | 920.3 | 4108.3 | 342.4 | 16.67 | nb: no. of bars |
| 5 | 842.7 | 4315.0 | 359.6 | 15.62 | 5 =< nb <= 19 |
| 6 | 753.7 | 4487.2 | 373.9 | 14.58 | |
| 7 | 658.7 | 4614.2 | 384.5 | 13.53 | |
| 8 | 575.1 | 4578.1 | 381.5 | 12.48 | press [PgDn] for |
| 9 | 488.4 | 4490.9 | 374.2 | 11.44 | factored loads |
| 10 | 332.9 | 4063.2 | 338.6 | 9.34 | |
| 11 | 181.0 | 3331.1 | 277.6 | 7.25 | press F5 HELP [ENTER] |
| 12 | .0 | 2212.0 | 184.3 | 5.15 | for help |

COLUMN PILES – PINNED LONGITUDINAL
CHECK OF 'CIRCOL' PROGRAM



#115

AREA OF COMPRESSION IS CALCULATED AS FOLLOWS:

$y = r\cos\theta/2$ , $c = r(1-\cos\theta/2)$

$A = \frac{\theta}{360}(\pi r^2) - [2(r\sin\theta/2)][r\cos\frac{\theta}{2}](1/2)$

$r = 12''$

$c = 12(1-\cos\theta/2)$

$A = \frac{\theta}{360}(\pi(12)^2) - [2(12)\sin\theta/2][12\cos\theta/2](1/2)$

$A = 1.26\,\theta - 144(\sin\theta/2)(\cos\theta/2)$

$= 1.26\theta - 72\sin\theta$

$\bar{y} = \frac{2/3\, r\sin^3\theta/2}{\frac{\pi}{360}\theta/2 - \sin\theta/2\cos\theta/2} = \frac{8\sin^3\theta/2}{\frac{\theta}{115} - 1/2\sin\theta}$

ASSUME 2 BARS OF STEEL YIELDS, NEGLECT OTHERS

$T = 40\text{ksi}(2)(1.56) = 124.80\text{ K}$

$C = (.85)^2(1.26\theta - 72\sin\theta)(2.5)$

$C = T$

$1.26\theta - 72\sin\theta - 69.1 = 0$

$\theta = 109°$

$a = .85c = 4.3''$

$\bar{y} = \frac{8\sin^3(\frac{109}{2})}{\frac{109}{115} - 1/2\sin 109} = 9.09''$

$M = 124.8(12 - 6.25 + 9.09)(\frac{1}{12}) = 154.4$ ft-k

TO INCLUDE COMPRESSION STEEL COMPUTER PROGRAM 'CIRCOL' IN LOTUS 1-2-3 WILL BE USED

LOADING TRANSVERSE TO BRIDGE DECK

ASSUME BRIDGE IS RESTRAINED LONGITUDINALLY SO THAT ONLY TRANSVERSE MOTION IS POSSIBLE. THE ELASTIC MOMENTS OBTAINED FROM THE RESPONSE SPECTRUM ANALYSIS ARE MUCH HIGHER THAN THE ALLOWABLE MOMENTS. THEREFORE THE ELASTIC MOMENTS WILL BE REDUCED BY A FACTOR OF SIX TO ACCOUNT FOR THE DUCTILITY OF THE COLUMNS AND THE FREQUENCY OF THE LOADING. THE SHEAR AND AXIAL LOADS OBTAINED FROM THE ELASTIC ANALYSIS ARE ALSO MUCH HIGHER THAN THE REALISTIC RESULTS. BY ASSUMING PLASTIC HINGING IN THE COLUMNS, THE MAXIMUM OBTAINABLE SHEARS AND AXIAL FORCES CAN BE OBTAINED. THESE VALUES WILL THEN BE CHECKED VERSUS THE CAPACITIES OF THE INDIVIDUAL COLUMNS.

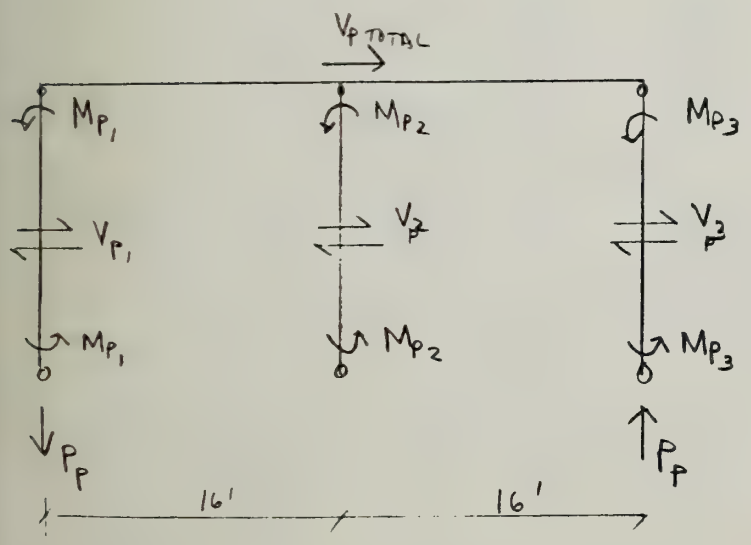
BENT 4 (HIGHEST MOMENT)

COLUMN HEIGHT 15'

TOTAL DEAD LOAD = $174.7 + 2(8.6) + \frac{3}{2}(7.1) = 202.6^k$

SCALE FACTOR TO BE APPLIED TO FRAME 2C RESULTS $S = \frac{202.6}{195.3} = 1.04$

INITIAL AXIAL LOAD ON COLUMNS DUE TO SEISMIC = $77^k$ (E.A.T.)




| COLUMN | ° $P_P$ | * $M_P$ | ‡ $V_P$ |
|---|---|---|---|
| 1 | +16 | 234 | 31.2 |
| 2 | -81 | 302 | 40.2 |
| 3 | -138 | 339 | 45.1 |
| TOTAL | | | 116.5 |
| 1 | -6 | 247 | 32.9 |
| 2 | -81 | 302 | 40.2 |
| 3 | -116 | 325 | 43.3 |
| | | | 116.4 ≈ 116.5 |

* $M_P = 1.3 \times M_u$, $V_P = \ddagger\ 2M_u \div 15'$

° $P_P = [5V_P - M_{P_1} - M_{P_2} - M_{P_3}] \div 32 + [illegible]$

LOADING TRANSVERSE TO BRIDGE DECK CENT.

CHECK BENDING MOMENT

| COLUMN | $P_f$ | $M'_u$ * | $M_{EXT}$ | $\frac{M_{EXT}}{M'_u}$ |
|---|---|---|---|---|
| 1 | -6 | 171 | 966 | 5.1 |
| 2 | -81 | 184 | 928 | 5.0 |
| 3 | -116 | 175 | 966 | 4.9 |

5.1 < 6.0 O.K.

* $\phi = 0.9$ FOR $P = 0$
$\phi = 0.7$ FOR $P = 0.1 f'_c A_g = 112^k$

| COL | DL LOAD FACTOR | AXIAL LOAD L | AXIAL LOAD E | $P_f$ | $M_p$ | $V_f$ | $M'_u$ ++ | $M_{EXT}$ | $\frac{M_{EXT}}{M'_u}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.12 | -65. | +56 | -9 | 260 | 21 | | | |
| 2 | | -87 | 0. | -87 | 309 | 25 | | | |
| 3 | | -65. | -56. | -121 | 325 | 26 | | | |
| TOTAL | | | | | | 72 | | | |
| 1 | | -65. | +28. | -37 | 286 | 23 | 154 | 640 | 4.2 |
| 2 | | -87 | 0 | -87 | 309 | 25 | 166 | 666 | 4.0 |
| 3 | | -65. | -28 | -93 | 312 | 25 | 169 | 640 | 3.8 |
| | | | | | | 73 | | | |
| 1 | 1.13 | -66 | +63 | -3 | 255 | 26 | | | |
| 2 | | -88 | 0 | -88 | 310 | 31 | | | |
| 3 | | -66 | -63 | -129 | 339 | 34 | | | |
| TOTAL | | | | | | 91 | | | |
| 1 | | -66 | +29 | -37 | 286 | 29 | 154 | 702 | 4.6 |
| 2 | | -88 | 0 | -89 | 310 | 31 | 167 | 739 | 4.4 |
| 3 | | -66 | -29 | -95 | 315 | 32 | 170 | 702 | 4.1 |
| | | | | | | 92 | | | |
| 1 | 1.0 | -59 | +52 | -7 | 258 | 47 | | | |
| 2 | | -78 | 0 | -78 | 302 | 55 | | | |
| 3 | | -59 | -52 | -111 | 325 | 59 | | | |
| TOTAL | | | | | | 161 | | | |
| 1 | | -59 | +29 | -31 | 273 | 50 | 147 | 612 | 4.2 |
| 2 | | -78 | 0 | -78 | 302 | 55 | 163 | 670 | 4.1 |
| 3 | | -59 | -28 | -87 | 309 | 56 | 166 | 612 | 3.7 |
| | | | | | | 161 | | | |

++ $\phi = 0.7$

LOADING TRANSVERSE TO BRIDGE DECK, CONT.

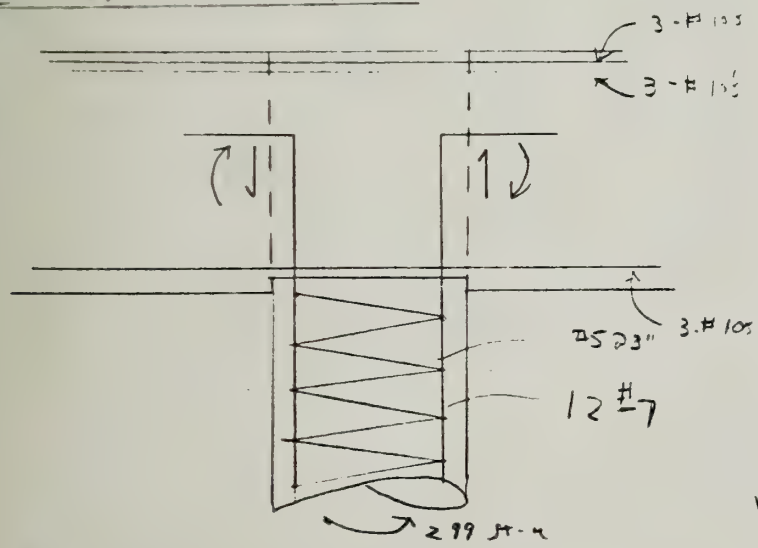
| COL | DL | LL | WIND | $P_P$ | $M_P$ | $V_P$ | #$M'_n$ | $M_{E}$ | $\frac{M_E}{M_n}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.82 | -49 | +59 | +10 | 241 | 48 | | | |
| 2 | | -65 | 0 | -65 | 299 | 60 | | | |
| 3 | | -49 | -59 | -108 | 325 | 65 | | | |
| | | | | | | 173 | | | |
| 1 | | -49 | +27 | -22 | 273 | 55 | 147 | 657 | 4.5 |
| 2 | | -65 | 0 | -65 | 299 | 60 | 161 | 711 | 4.4 |
| 3 | | -49 | -27 | -76 | 301 | 60 | 162 | 657 | 4.1 |
| | | | | | | 175 | | | |

# $\phi = 0.7$

ALL OF THE ELASTIC MOMENTS OBTAINED IN THE ANALYSIS ARE LESS THAN 6.0 TIMES THE ALLOWABLE ULTIMATE MOMENT.

THE MAXIMUM OBTAINABLE SHEAR IS 60 KIPS. SO THE COLUMN MUST BE CHECKED FOR THIS VALUE. THE CONNECTION MUST BE CHECKED FOR THE SHEAR DUE TO COLUMN MOMENT

SHEAR AT CONNECTION




HORIZ. SHEAR MUST BE TAKEN THRU SHEAR FRICTION & CONCRETE

$V_C = 0.85(2)(\sqrt{2500})(36)$
$= 38^k$

SINCE SECTION IS IN COMPRESSION:
$V_{S_H} = 0.85[(12)(0.6)(40)](0.6)$
$= 147^k$

$V_{n_H} = 147 + 38 = 185 > 60$

IN BEAM VERTICAL SHEAR IS:
$V_V = \frac{M}{\ell} = \frac{299}{1.5} = 199^k$, $V_{C_V} = .85(2)(\sqrt{2500})(24)(27) = 55^k \not> 199$

NO GOOD

SHEAR IN COLUMN

$$V_c = 2\sqrt{2500}\,(3.19)(144) = 45^k$$

$$V_s = \frac{2(31)(21'')(40)}{\#5\text{'s } 3 \text{ crossings } @3''} = 174^k$$

$$V_n' = 0.85(45+174) = 186^k > 60 \quad \text{o.k.}$$

DISPLACEMENTS

$\Delta_L = 2.3'' \ \& \ 1.0'$

$\Delta_{T_{MAX}} = 6.1''$

$\Delta_{T_{MIN}} = 2.3''$

IN THE LONGITUDINAL DIRECTION THE DISPLACEMENT WILL BE LARGER THEN THE 1" OF EXPANSION MATERIAL BETWEEN THE BRIDGE DECK SECTIONS. THIS MEANS THAT LONGITUDINALLY THE BRIDGE SECTIONS WILL INTERACT WITH EACH OTHER. THIS COULD CAUSE SEVERE PROBLEMS IN THE DECK IF THE DECK SECTIONS AT THE HINGES MOVE VERTICALLY RELATIVE TO EACH OTHER. TO ALLEVIATE THIS PROBLEM THE DECKS WILL BE TIED TOGETHER VERTICALLY AND LONGITUDINALLY.

THE TRANSVERSE DISPLACEMENT AT ONE END IS VERY HIGH DUE TO ROTATION OF THE BRIDGE DECK CREATED BY THE ECCENTRICITY BETWEEN THE TRANSVERSE CENTER OF RIGIDITY AND THE CENTER OF MASS. TO REDUCE THE LARGE DISPLACEMENT AND POSSIBLE OTHER UNFORSEEN PROBLEMS DUE TO THIS ROTATION, THE BRIDGE SECTIONS WILL BE CONNECTED TRANSVERSELY AT THE HINGES.

REANALYSIS (2 SECTION MODEL)

THE ORIGINAL ANALYSIS SHOWS THAT THE DUCTILITY REQUIREMENTS OF THE COLUMN CONNECTIONS ARE MUCH HIGHER THAN THE ALLOWABLES. THE PROBLEM IS TWOFOLD:

1) THE SPIRALS OF THE COLUMN DO NOT EXTEND INTO THE BENT CAP, SO THE REDUCTION FACTOR OF THE CONNECTION IN BENDING IS 3.0 RATHER THAN THE VALUE OF 8.0 FOR A WELL CONFINED COLUMN.
2) THE SHEAR IN THE CONNECTION IS TOO HIGH TO BE CARRIED BY THE CONCRETE SO THAT THE JOINT WILL SEVERLY CRACK AND LOSE ITS INTEGRITY, THUS RENDERING IT USELESS.

BOTH OF THESE PROBLEMS CAN BE SOLVED BY PLACING CAPITALS ATOP THE COLUMNS. BY BOLTING THRU THE COLUMN OR PRESTRESSING THROUGH IT, THE COLUMN WILL BECOME A CONFINED SECTION. THEREFORE, A REDUCTION FACTOR OF Z = 8.0 CAN BE USED. THE SHEAR IN THE LONGITUDINAL DIRECTION IN THE CONNECTION WILL BE CARRIED BY THE PRESTRESSING. IN THE TRANSVERSE DIRECTION STEEL PLATES WILL BE CONNECTED TO THE BENT CAP TO CARRY THE LOAD.

THE DISPLACEMENT IN THE TRANSVERSE DIRECTION WERE VERY LARGE. THIS COULD CAUSE COMPLICATIONS IN THE DECK SLAB AT THE HINGES SINCE THEY ARE NOT TIED TOGETHER VERTICALLY. TO ALLEVIATE THIS PROBLEM THE DECKS WILL BE TIED TOGETHER AT THE HINGES LONGITUDINALLY, TRANSVERSELY AND VERTICALLY.

THEREFORE THE NEW COMPUTER MODEL WILL TAKE INTO ACCOUNT 2 - 100' SECTIONS, SO THAT THE HINGE IS INCLUDED.

COMPUTER MODEL - REANALYSIS 2-100' SECTIONS

THE SAME ASSUMPTIONS AS THE ORIGINAL MODEL EXCEPT FOR THE FOLLOWING:

1) THE CRACKED SECTION MOMENT OF INERTIAS $I_{CR} = \frac{I_g}{2}$ WILL BE USED FOR THE COLUMNS, SLABS, AND BENT CAPS. THE REASON FOR THIS IS THAT IN THE ORIGINAL ANALYSIS ALL ELEMENTS WERE NEAR THEIR ULTIMATE CAPACITY.
2) TWO 100' SECTIONS WILL BE INCLUDED RATHER THAN ONE 100' SECTION.
3) SINCE THE PROGRAM CAN ONLY HANDLE 10 SPANS, THE LAST COLUMN BENT AND 5' OVERHANG WILL NOT BE INCLUDED.
4) AT THE ENDS THE ABUTMENTS WILL SUPPORT VERTICAL LOAD BUT NO LONGITUDINAL LOAD. TRANSVERSELY A STIFFNESS CORRESPONDING TO THE NEXT COLUMN BENT WILL BE INCLUDED.
5) AN END JOINT OF 2' AT THE TOP OF THE COLUMNS WILL BE INCLUDED TO CUT DOWN THE COLUMN SPANS DUE TO THE BENT CAP DEPTH.

/BLUME

ssie Street (at New Montgomery)

ancisco, California 94105

| | | | |
|---|---|---|---|
| 9439 | JOB SF BRIDGES | BY GLM | DATE 11/7/82 |
| | SUBJECT MARKET ST. VIADUCT #3 | CHK'D | DATE |

SHEET NO. 33




○ - LONGITUDINAL HINGE AT COLUMN - CAP INTERFACE

⊕ - HINGE IN BASE CELL

□ - SPAN ELEMENTS

○ - BENT COLUMN ELEMENTS

△ - BENT CAP ELEMENTS

2. SECTIONS MODEL

COMPUTER MODEL 2 SPANS

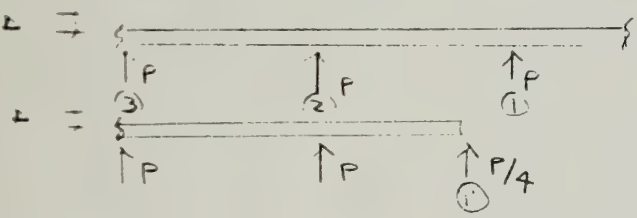
STIFFNESS OF ENDS

COLUMN HEIGHT 9'
LOAD = 100 K
DEFL. = .01102'

$$K = \frac{P}{\Delta} = \frac{100}{.01102} = 9074 \text{ K/'}$$

ASSUME THAT THE STIFFNESS IS DISTRIBUTED; THAT THE COLUMN WILL TAKE ITS TRIBUTARY LOAD. ASSUMING THE DECK TO BE RIGID TRANSVERSELY, THE SYSTEM CAN BE VIEWED AS A BEAM ON ELASTIC FOUNDATION WITH A UNIFORM DEFLECTION ACCROSS ITS SPAN, SO THE STIFFNESS IS PROPORTIONAL TO ITS LOAD

ABUTMENT I

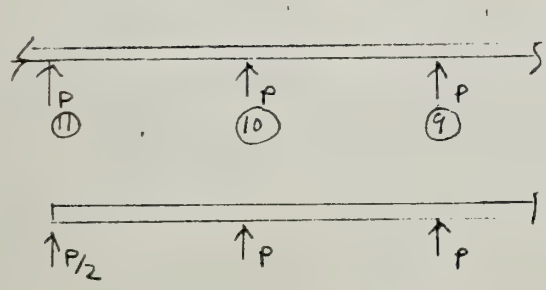



ACTUAL CONDITION

MODELED CONDITION

$$K_{I}' = \frac{K}{4} = \frac{9074}{4} = 2268' = 2270'$$

ABUTMENT II




ACTUAL CONDITION

MODELED CONDITION

$$K_{II} = \frac{K}{2} = \frac{9074}{2} = 4537 \approx 4500 \text{ K/'}$$

FRAME 2

| | | | | | |
|---|---|---|---|---|---|
| .00 | [illegible] | [illegible] | .00 | 36.120 | [illegible] |

| X | Y | R |
|---|---|---|
| .000 | -27.770 | 51.750 |
| .000 | -7.070 | .000 |
| .000 | -27.770 | -51.750 |
| 100.000 | .000 | .000 |

| | NODAL COORDINATES | | BOUNDARY CONDITIONS | | ELASTIC SUPPORT | |
|---|---|---|---|---|---|---|
| LE | X | Y | X | Y | | |
| 11 | .000 | .000 | .000 | .000 | .000 | [illegible] |
| | | | .000 | .000 | .000 | |
| | | | .000 | .000 | .000 | |
| 0 | .000 | 8.000 | .000 | -77.770 | 91.750 | [illegible] |

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|
| [illegible] | 1 | 1 | 0 | 0 | 4.[illegible] | 4.[illegible] |
| [illegible] | 1 | 1 | [illegible] | [illegible] | 4.[illegible] | [illegible] |
| 4 | 1 | [illegible] | 0 | 1 | 4.0 | 4.[illegible] |
| 5 | 1 | [illegible] | [illegible] | 1 | [illegible] | [illegible] |

| X-DISPLACEMENT | Y-DISPLACEMENT | Z-ROTATION |
|---|---|---|
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | -.00037 | -.00018 |
| .01101 | .00007 | -.00077 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 |
| .00000 | -.00048 | .000[illegible] |
| .01102 | .00000 | -.00001 |
| .00000 | .00000 | .00000 |

| | | |
|---|---|---|
| [illegible] | [illegible] | .147 |
| [illegible] | [illegible] | [illegible] |
| .000 | .000 | .000 |
| [illegible] | [illegible] | [illegible] |
| .010 | .000 | .000 |
| .000 | .000 | .000 |
| .000 | [illegible] | .000 |
| -[illegible] | .000 | 152.019 |
| .000 | .000 | .000 |
| .000 | -7.670 | .000 |
| 100.000 | .000 | .000 |
| .000 | .000 | .000 |
| -7.681 | 50.847 | 7.149 |
| -30.791 | 11.469 | 137.550 |
| .000 | .000 | .000 |
| .000 | -[illegible].770 | -[illegible] |
| .005 | .000 | .000 |
| .000 | .000 | .000 |

MODAL REFERENCE (2-100 SECTION)

THE COMPUTER MODAL USED TO MODEL OF THE SPAN. TO SEE IF THIS IS ADEQUATE TO CAPTURE THE TRUE STRUCTURAL RESPONSE, THE EFFECTIVE MODAL MASS WILL BE DETERMINED (THE EFFECTIVE MODAL MASS IS EQUAL TO THE SUM OF THE SQUARE OF THE FACTORS $\Gamma_i$). THIS WILL THEN BE COMPARED TO THE TOTAL STRUCTURAL MASS

STRUCTURAL MASS

DECK $8.69\ k/l \times 195' =$ $1695 \div 32.2 = 52.63$

COLUMNS $3(3.14)^{3/4}(.15)(13+14+15+17+21+23+20+14+11) =$ $159 \div 32.2 = 4.94$

TOTAL $= 1854 \div 32.2 = 57.57$

| MODE | DESCRIPTION | $\Gamma$ | $(\Gamma)^2$ | $\Sigma \Gamma_L^2$ | % $M_L$ | $\Sigma \Gamma_T^2$ | % $M_T$ |
|---|---|---|---|---|---|---|---|
| 1 | TRANSVERSE | 6.055 | 36.66 | | | 36.66 | 63.7 |
| 2 | LONGITUDINAL | 7.439 | 55.34 | 55.34 | 96.1 | | 76.9 |
| 3 | TRANS. | 2.763 | 7.63 | | | 44.30 | |
| 4 | TRANS. | 3.435 | 11.80 | | | 56.10 | 97.4 |

REF: GLMSEISB2P3D.OUT 11/8/94

SINCE AT LEAST 96% OF THE MASS IS EFFECTIVE IN JUST THE FIRST 4 MODES, THE COMPUTER RESULTS ARE ACCURATE ENOUGH TO CAPTURE THE TOTAL STRUCTURAL RESPONSE

INTERPRETATION OF COMPUTER RESULTS

THE COMPUTER RESULTS WERE OBTAINED FROM A PURELY ELASTIC ANALYSIS. THIS WOULD BE COMPLETELY ADEQUATE IF THE STRUCTURE HAD REMAINED COMPLETELY ELASTIC. HOWEVER, DUE TO THE EXTREMELY LARGE LOADING APPLIED TO THE BRIDGE THE ELASTIC ANALYSIS PRODUCES RESULTANT STRESSES IN EXCESS OF THE BRIDGE'S CAPACITY. IN REALITY BEFORE ANY OF THESE HIGH LOADS CAN BE OBTAINED PLASTIC HINGES WILL FORM WHICH WILL LIMIT THE LOAD WHICH THE COLUMNS CAN HANDLE. THIS IN TURN WILL LIMIT THE COLUMN BASE SHEARS. THEREFORE, THE MAXIMUM LOAD THE STRUCTURE CAN OBTAIN IS LIMITED BY THE TOTAL BASE SHEARS OF THE COLUMNS. ASSUMING THAT ALL THE COLUMNS YIELD AND FORM PLASTIC HINGES TOP AND BOTTOM, THE MAXIMUM BASE SHEAR THAT THE BRIDGE CAN POSSIBLY ABSORB IS OBTAINED.

THE ACTUAL LOAD TO THE BRIDGE WILL NOT BE THIS HIGH UNLESS ALL COLUMNS WERE TO FORM PLASTIC HINGES. HOWEVER, THIS VALUE WILL BE USED AS AN UPPERMOST VALUE FOR CHECKING STRESSES.

USE OF COMPUTER RESULTS

BY OBTAINING THE ALLOWABLE PLASTIC MOMENT FOR EACH COLUMN, THE CORRESPONDING MAXIMUM SHEARS IN THE COLUMNS CAN BE OBTAINED. TO OBTAIN THE PLASTIC MOMENTS OF THE SECTIONS, THE AXIAL LOADS IN THE COLUMNS MUST BE KNOWN. AS A STARTING POINT THE AXIAL LOADS WILL BE THOSE FOUND FROM THE ELASTIC COMPUTER ANALYSIS COMBINED WITH DEAD LOAD. KNOWING THE AXIAL LOAD, THE PLASTIC MOMENTS AND SHEARS ARE OBTAINED. FROM THE PLASTIC MOMENTS AND SHEARS, THE AXIAL LOADS ARE RECOMPUTED TO SATISFY STATICS. THE PROCESS IS THEN REPEATED UNTIL THE SOLUTION CONVERGES.

THE TRANSVERSE AND LONGITUDINAL DIRECTIONS WILL BE VIEWED SEPERATELY. THE REASON FOR THIS IS THAT WHEN A HINGE FORMS IN ONE DIRECTION THE OTHER DIRECTION HAS NO CAPACITY. SINCE THERE IS NO CAPACITY NO BASE SHEAR CAN ENTER THE STRUCTURE

ONCE THE PLASTIC MOMENTS ARE OBTAINED AND THE SHEARS AND AXIAL LOADS OBTAINED, THE ULTIMATE CAPACITY OF THE COLUMNS WILL BE FOUND. THIS CAPACITY WILL THEN BE COMPARED TO THE ELASTIC COMPUTER RESULTS*. SINCE THE COLUMNS FORM WELL CONFINED MULTI-COLUMN BENTS, THE Z-FACTOR (REDUCTION FACTOR FOR ELASTIC RESULTS) IS 8. (SINCE ALL STRUCTURAL PERIODS ARE LESS THAN 0.6 SEC) THIS IS SHOWN IN AASHTO SPECS 1.2.20.

* THE ELASTIC RESULTS INCLUDE REACTIONS DUE TO THE ROTATION OF THE BRIDGE

S/BLUME

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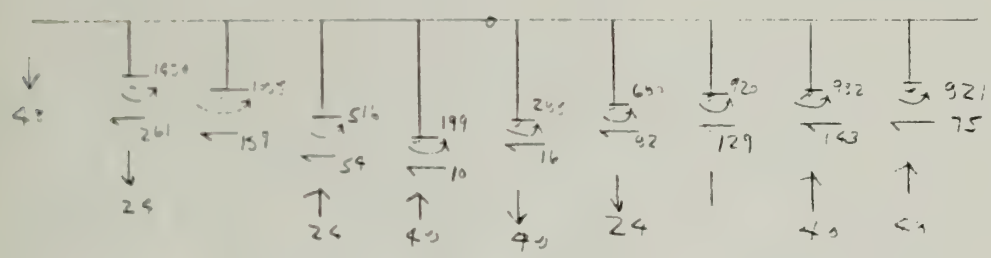
SHEET NO.

NO. JOB SF BRIDGES BY GIM DATE

SUBJECT MARKET ST. VIADUCT X 3 CHK'D DATE

[illegible] LOAD = 2-100' BRIDGE [illegible] CRANES




M = + 6919

Vh = - 16579

$P = \frac{16579 - 6919}{400} = 24.2$

LONGITUDINAL LOAD - 2-100' BRIDGE SECTION, CRACKED SECTION

REDISTRIBUTION OF LOADS

THE MODEL WAS REDUCED BY ONE BAY, SO THE LONGITUDINAL STIFFNESS FOR THE COLUMNS IN THE LAST BENT WAS NOT INCLUDED. IF THE COLUMNS WOULD HAVE BEEN INCLUDED THEY WOULD HAVE ABSORBED SOME OF THE LOAD. ASSUMING THAT THE STIFFNESSES OF THE COLUMNS ARE PROPORTIONAL TO $\frac{1}{\ell^3}$, THE TOTAL SHEAR OF THE SYSTEM WILL BE REDISTRIBUTED TO INCLUDE THE ADDED COLUMN BENT.

CHECK TO SEE IF OBTAINED RESULTS AGREE WITH THIS

$K_{TOT} = K_2 + K_3 + K_4 + K_5 + K_6 + K_7 + K_8 + K_9 + K_{10}$

$= \frac{1000(.8)}{(11)^3} + \frac{1000}{(12)^3} + \frac{1000}{(13)^3} + \frac{1000}{(15)^3} + \frac{1000(.9)}{(19)^3} + \frac{1000(.9)}{(23)^3} + \frac{1000}{(15)^3} + \frac{1000}{(12)^3} + \frac{1000}{(10)^3}$

$= 0.376 + 0.579 + 0.455 + 0.296 + 0.073 + .041 + .171 + .579 + 1.372 = 3.942$

$V\% = .095 + .147 + .115 + .075 + .019 + .010 + .043 + .147 + .349 = 1.0$

$V_{TOTAL\ COMPUTER} = 82 + 164 + 146 + 93 + 18 + 11 + 61 + 181 + 310 = 1066^K$

$V_{FROM\ K} = 101 + 156 + 123 + 80 + 20 + 11 + 46 + 157 + 371 = 1065^K$

$\% = \frac{V_{COMPUTER}}{V_K} = .81,\ 1.05,\ 1.19,\ 1.16,\ .9,\ 1.0,\ 1.33,\ 1.15,\ 0.84$

THE COMPARISONS ARE CLOSE SO THE PROCESS WILL BE CARRIED OUT TO INCLUDE THE ADDITIONAL BENT

$K_{11} = \frac{1000(.9)}{(10)^3} = 0.977$ ASSUMING CHARACTERISTICS ARE SIMILAR TO COLUMN 6 $R = 0.9$.

$K_{INCLUDING\ K} = .305 + .608 + .541 + .343 + .066 + .041 + .227 + .666 + 1.152 + .979 = 4.323$

$V\% = .063 + .126 + .112 + .071 + .014 + .008 + .047 + .138 + .239 + .182 = 1.0$

SINCE 5' OF BRIDGE WAS NOT INCLUDED IN MODEL, ADD IN 5 SECTION WITH $S_a = 1.69$ $V_{ADDED} = 5(8.69^K)(1.6) = 70^K$, $V_{TOTAL} = 1065 + 70 = 1135^K$

| | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_{10}$ | $V_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{FROM\ K} =$ | 72 + | 143 + | 127 + | 81 + | 16 + | 9 + | 53 + | 157 + | 272 + | 207 = 1137$^K$ |

LONG LOAD - 2-100 BRACE SEGMENT, BRACED SEGMENT, AND
REDISTRIBUTION OF LOADS

THE MOMENTS WILL BE CALCULATED FROM THE SHEARS
& ASSUMES THAT THE MOMENT TO SHEAR RATIO WILL
BE EQUAL TO THAT FOUND FROM THE COMPUTER MODEL.

$R = \frac{M_{MODEL}}{V_{MODEL}}$, $R_2 = \frac{995}{92} = 10.9$, $R_3 = \frac{1107}{164} = 6.9$, $R_4 = \frac{1029}{146} = 7.0$, $R_5 = \frac{765}{93} = 8.2$
$R_6 = \frac{315}{18} = 17.5$, $R_7 = \frac{219}{11} = 19.9$, $R_8 = \frac{575}{61} = 9.4$, $R_9 = \frac{1163}{181} = 6.5$, $R_{10} = \frac{1075}{197} = 5.4$

TO OBTAIN RATIO FOR COLUMN 11 ASSUME IT IS
SIMILAR TO $R_6$. SO THE RATIO WILL BE THAT OF
COLUMN 6 RATIOED BY THEIR RESPECTIVE HEIGHT

$R_{11} = R_6 \frac{H_{11}}{H_6} = 17.5\left(\frac{9}{19}\right) = 7.4$

| | $M_2$ | $M_3$ | $M_4$ | $M_5$ | $M_6$ | $M_7$ | $M_8$ | $M_9$ | $M_{10}$ | $M_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $M_{FROM V}$ = | 785, | 972, | 889, | 664, | 280, | 178, | 499, | 1021, | 1467, | 1532 |

BY REDISTRIBUTING THE LOADS IN THIS FASHION IT
CAN BE SEEN THAT ALL COLUMNS EXCEPT 1 REQUIRE A
REDUCTION FACTOR OF LESS THAN 8.0*. THE ONE
COLUMN IS COLUMN BENT 11. THIS COULD BE A LITTLE
FICTIOUS DUE TO THE REDISTRIBUTION SCHEME, HOWEVER,
EVEN IF IT WERE OVER 8.0 IT IS ONLY 4% OVER.
IN REALITY THE COLUMN WILL NEVER ABSORB THAT
MUCH LOAD, SINCE AS IT BEGINS TO HINGE IT WILL
ROTATE AND THE OTHER COLUMNS WILL ABSORB THE LOAD.
SO AS LONG AS THE SECTION IS ADEQUATELY
CONFINED, THE COLUMNS ARE ADEQUATE FOR THIS LOADING.

* SEE FOLLOWING sheet

SHEET NO. [illegible]
JOB [illegible] BY [illegible] DATE [illegible]
SUBJECT [illegible] CHK'D DATE

[illegible] LOAD - 2 - 100' BRIDGE OF THREE CRANES [illegible]

| SEGMENT | DL (1) | LL | PP | Mp | Vp | M'u | (3) Mcr | Mcr/M'u | Mcr/M'u |
|---|---|---|---|---|---|---|---|---|---|
| 2 | -63 | -48 | -111 | 324 | 25 | | | | |
| 3 | -66 | -24 | -90 | 311 | 44 | | | | |
| 4 | -66 | 0 | -66 | 296 | 39 | | | | |
| 5 | -66 | +24 | -42 | 281 | 33 | | | | |
| 6 | -71 | +48 | -23 | 269 | 13 | | | | |
| 7 | -71 | -49 | -119 | 330 | 13 | | | | |
| 8 | -69 | -24 | -93 | 313 | 31 | | | | |
| 9 | -65 | 0 | -65 | 296 | 42 | | | | |
| 10 | -71 | +24 | -47 | 284 | 52 | | | | |
| 11 | (2) -70 | +48 | -22 | 268 | 27 | | | | |
| | | | | 2972 | 317 | | | | |
| 2 | -63 | -9 | -72 | 300 | 23 | 186 | 705 | 4.2 | 0.53 |
| 3 | -66 | -4 | -70 | 299 | 43 | 186 | 972 | 5.2 | 0.66 |
| 4 | -66 | 0 | -66 | 296 | 39 | 185 | 889 | 4.8 | 0.60 |
| 5 | -66 | +4 | -62 | 294 | 35 | 184 | 664 | 3.6 | 0.45 |
| 6 | -71 | +9 | -62 | 294 | 14 | 184 | 280 | 1.5 | 0.19 |
| 7 | -71 | -9 | -80 | 305 | 12 | 186 | 178 | 0.96 | 0.12 |
| 8 | -69 | -4 | -73 | 301 | 31 | 186 | 498 | 2.7 | 0.33 |
| 9 | -65 | 0 | -65 | 296 | 42 | 185 | 1021 | 5.5 | 0.69 |
| 10 | -71 | +4 | -67 | 297 | 54 | 185 | 1467 | 7.9 | 0.99 |
| 11 | -70 | +9 | -61 | 293 | 29 | 185 | 1532 | 8.3 | 1.04 |
| | | | | 3075 | 322 | | | | |

(1) FROM COMPUTER OUTPUT GLMS15C23D5.OUT 11/6/84. MUST ADD 1/4 OF DL OF COLUMN TO GET TOTAL DL

(2) MUST ADD ENTIRE DL OF COLUMN PLUS 15' OF DECK DL.

$$W = \frac{-66.9 + 15'(0.69-1)}{3} + (0.15\ kcf)(3.14\ ft^2)(10') = 70^k$$

(3) FROM COMPUTER OUTPUT GLMSE15B2P3D.OUT 11/9/84

TRANSVERSE LOAD - 2-100' BRIDGE [illegible] CRACKED SECTION [illegible]

BENT 11 MOMENT

ASSUME MOMENTS IN BENT ARE DISTRIBUTED AT PER FRAME 2C LATERAL LOAD ANALYSIS, TOTAL SHEAR [illegible] LOAD IN ABUTMENT 11 IN COMPUTER RUN SUMMARY [illegible] AND ADDITIONAL 10' OF SPAN WITH 1.6g ACCEL. LEVEL

$$V = 266 + 10(9.69)(1.6) = 405^k$$

SCALE FACTOR FOR FRAME 2C $= \frac{405}{100} = 4.05$

$$M_1 = M_3 = 137.6\,(4.05) = 557 \text{ ft-k}$$

$$M_2 = 158.0\,(4.05) = 640 \text{ ft-k}$$

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SHEET NO.

JOB SF BRIDGES BY GLM DATE

SUBJECT MARVEL [illegible] #3 CHK'D DATE

TRANSVERSE LOAD - 2-[illegible] BRIDGE SEGMENT, CRANKED [illegible]

| [illegible] | [illegible] | [illegible] | [illegible] | Pp | Mp | Vp | M'm | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.97 | -57 | +43 | -14 | 264 | 49 | | | |
| 2 | | -75 | 0 | -75 | 302 | 55 | | | |
| 3 | | -57 | -43 | -100 | 318 | 58 | | | |
| | | | | | | 161 | | | |
| 1 | | -57 | +38 | -19 | 267 | 48 | 180 | 362 | 2.0 |
| 2 | | -75 | 0 | -75 | 302 | 55 | 186 | 441 | 2.4 |
| 3 | | -57 | -38 | -95 | 314 | 57 | 187 | 362 | 1.9 |
| | | | | | | 160 | | | |
| 1 | 1.02 | -60 | +59 | -1 | 255 | 43 | | | |
| 2 | | -79 | 0 | -79 | 304 | 51 | | | |
| 3 | | -60 | -59 | -119 | 330 | 55 | | | |
| | | | | | | 149 | | | |
| 1 | | -60 | +37 | -23 | 269 | 45 | 180 | 497 | 2.9 |
| 2 | | -79 | 0 | -79 | 304 | 51 | 186 | 598 | 3.2 |
| 3 | | -60 | -37 | -97 | 316 | 53 | 187 | 497 | 2.7 |
| | | | | | | 149 | | | |
| 1 | 1.02 | -60 | +37 | -23 | 269 | 41 | 180 | 747 | 4.2 |
| 2 | | -79 | 0 | -79 | 304 | 47 | 186 | 890 | 4.7 |
| 3 | | -60 | -37 | -97 | 316 | 49 | 187 | 747 | 4.0 |
| | | | | | | 137 | | | |
| 1 | | -60 | | | | | | | |
| 2 | | -79 | | | | | | | |
| 3 | | -60 | | | | | | | |
| 1 | 1.02 | -60 | +36 | -24 | 270 | 36 | | | |
| 2 | | -79 | 0 | -79 | 304 | 41 | | | |
| 3 | | -60 | -36 | -96 | 315 | 42 | | | |
| | | | | | | 119 | | | |
| 1 | | -60 | +35 | -25 | 270 | 36 | 180 | 856 | 4.8 |
| 2 | | -79 | 0 | -79 | 304 | 41 | 186 | 992 | 5.3 |
| 3 | | -60 | -35 | -95 | 314 | 42 | 187 | 856 | 4.6 |
| | | | | | | 119 | | | |

S/BLUME

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rancisco, California 94105

SHEET NO.

NO. [illegible] JOB SF BRIDGES BY GLM DATE [illegible]

SUBJECT MAPPER [illegible] VIAD [illegible] E2 CHK'D DATE

TRANSVERSE LOAD - 2-100' BRIDGE [illegible]

| | | | AXIAL LOAD | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $P_P$ | $M_P$ | $V_P$ | $M'_u$ | $M_{E.A.}$ | $\frac{M_{E.A.}}{M'_u}$ |
| | | 1.09 | -64 | +80 | +14 | 242 | 25 | | | |
| | 2 | | -85 | 0 | -85 | 309 | 32 | | | |
| | 3 | | -64 | -80 | -121 | 333 | 35 | | | |
| | | | | | | | 92 | | | |
| | 1 | | -64 | +33 | -31 | 274 | 29 | 181 | 752 | 4.2 |
| | 2 | | -85 | 0 | -85 | 308 | 32 | 186 | 849 | 4.6 |
| | 3 | | -64 | -33 | -97 | 316 | 33 | 187 | 752 | 4.0 |
| | | | | | | | 94 | | | |
| | 1 | 1.09 | -64 | +33 | -31 | 274 | 24 | 181 | 471 | 2.6 |
| | 2 | | -85 | 0 | -85 | 308 | 27 | 186 | 521 | 2.8 |
| | 3 | | -64 | -33 | -97 | 316 | 27 | 187 | 471 | 2.5 |
| | | | | | | | 78 | | | |
| | 1 | 1.06 | -62 | +55 | -7 | 259 | 29 | | | |
| | 2 | | -83 | 0 | -83 | 307 | 34 | | | |
| | 3 | | -62 | -55 | -117 | 328 | 36 | | | |
| | | | | | | | 99 | | | |
| | 1 | | -62 | +34 | -28 | 268 | 30 | 178 | 522 | 2.9 |
| | 2 | | -83 | 0 | -83 | 307 | 34 | 187 | 596 | 3.2 |
| | 3 | | -62 | -34 | -96 | 315 | 35 | 187 | 522 | 2.8 |
| | | | | | | | 99 | | | |
| | 1 | 1.0 | -59 | +76 | +17 | 240 | 40 | | | |
| | 2 | | -78 | 0 | -78 | 304 | 51 | | | |
| | 3 | | -59 | -76 | -135 | 340 | 57 | | | |
| | | | | | | | 148 | | | |
| | 1 | | -59 | +37 | -22 | 269 | 45 | 180 | 662 | 3.7 |
| | 2 | | -78 | 0 | -78 | 304 | 51 | 186 | 807 | 4.3 |
| | 3 | | -59 | -37 | -96 | 315 | 53 | 187 | 662 | 3.5 |
| | | | | | | | 149 | | | |

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SHEET NO.

NO. 3439 JOB SF BRIDGES BY GLM DATE 11/5/[illegible]

SUBJECT MARKER IN VIADUCT #3 CHK'D DATE

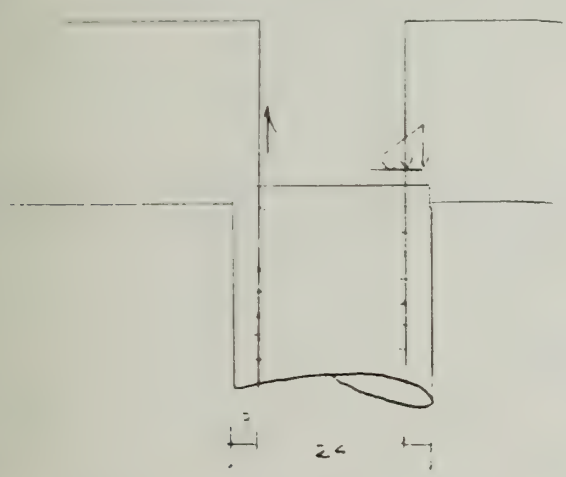
TRANSVERSE LOAD - 2-100' BRIDGE [illegible]

| [illegible] | DL SCALE FACTOR | AXIAL LOAD DL | AXIAL LOAD SEISMIC | Pp | Mp | Vp | M[illegible] | M[illegible] | M[illegible]/M[illegible] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.09 | -64 | +62 | -2 | 256 | 57 | | | |
| 2 | | -85 | 0 | -85 | 308 | 69 | | | |
| 3 | | -64 | -62 | -126 | 334 | 74 | | | |
| | | | | | | 199 | | | |
| 1 | | -64 | +40 | -24 | 270 | 60 | 180 | 524 | 2.9 |
| 2 | | -85 | 0 | -85 | 308 | 69 | 186 | 690 | 3.7 |
| 3 | | -64 | -40 | -104 | 320 | 71 | 188 | 524 | 2.8 |
| | | | | | | 199 | | | |
| 1 | .99 | -51 | +25 | -26 | 272 | 69 | | | |
| 2 | | -69 | 0 | -69 | 298 | 74 | | | |
| 3 | | -51 | -25 | -76 | 303 | 76 | | | |
| | | | | | | 219 | | | |
| 1 | | -51 | +41 | -10 | 261 | 65 | 178 | 557 | 3.1 |
| 2 | | -69 | 0 | -69 | 299 | 74 | 186 | 640 | 3.4 |
| 3 | | -51 | -41 | -92 | 313 | 78 | 187 | 557 | 3.0 |
| | | | | | | 217 | | | |

SHEAR IN COLUMN

$V_h' = 196^k > 79^k$ (VMAX BENT 11)

SHEAR IN CONNECTION
TRANSVERSE LOAD




VERTICAL SHEAR IS:

$V_V = \frac{M}{\ell} = \frac{320}{1.5} = 213^k$ $V_{CV} = 55^k > 213$

SO SHEAR PLATES MUST BE DESIGNED TO CARRY AT LEAST $V = 213 - 55 = 158^k$

LONGITUDINAL LOAD

$V_V = \frac{305}{1.5} = 203^k$

IN BENT CAP ABOVE COLUMN 2 #4 U-STIRRUPS EXIST.

$V_s = 2(2)(0.2)(40) = 32^k$

$V_h' = 55 + 0.85(32) = 82^k \not> 203^k$

SO COMPRESSION FORCE IN DOWELS MUST EQUAL AT LEAST

$V = 203 - 82 = 121^k$

DECK CAP

W = 42'

FROM [illegible]

$M^{(+)}_{3\mu} = \left(634.9 + \frac{646.5}{[illegible]}(1054 - 634.9)\right)\left(\frac{42}{40}\right) = 8787$ ft-k

$M^{1(+)}_{3\mu} = 0.9(8787) = 791$ ft-k

$M^{(-)}_{3\mu} = \left[1495.3 + \frac{237.9}{[illegible]}(1834.6 - 1495.3)\right]\left(\frac{42}{40}\right) = 1633$ ft-k

$M^{1(-)}_{3\mu} = 0.9(1633) = 1470$ ft-k

THE AXIAL LOAD IN THE DECK IS LIMITED BY THE TOTAL SHEAR $V_p = 322(3) = 966^k$ SO P CAN BE REDUCED BY THE FACTOR $\frac{966}{3(922)} = 0.35$

THE MAX $M_3$ OCCURS AT ELEMENT 36 NODE j - REF 4

EQ INC $M_{336j} = 2697$ ft-k, $M_{236j} = 7944(0.3) = 2383$, $P = .35(4[illegible]) = 162^k$

$M_{336i} = 1530$ ft-k, $M_{236i} = 7642(0.3) = 2293$

DL $M_{336j} = -325.5$ ft-k, $M_{336i} = 13$ ft-k REF. 3

THE ABOVE VALUES ARE AT THE ℄ OF THE BENT CAP AT THE FACE OF THE BENT CAP THE MOMENT WILL BE FOUND ASSUMING A LINEAR DISTRIBUTION FROM END i TO END j OF THE 5' SECTION. THE FACE IS 1' FROM BENT CAP ℄. A Z FACTOR OF 2.0 IS USED

SEISM

$M_3 = \left(2697 - \left(\frac{2697-1530}{5}\right)\right)\frac{1}{2.0} = 1232$ ft-k

$M_2 = \left(2383 - \left(\frac{2383-2293}{5}\right)\right)\frac{1}{2.0} = 1193$ ft-k

DL

$M_3 = -325.5 - \left(\frac{325.5+13}{5}\right) = -258$ ft-k

$0.1\, f'_c A_g = 0.1(2.5\text{ ksi})(42)(144) = 1512^k > 162^k$ SO AXIAL LOAD CAN BE NEGLECTED.

DECK SLAB, COL

$M_3^{(-)} = 1232 + 259 = 1491$ ft-k, $M_3^{(+)} = 1232 - 259 = 974$ ft-k

$\frac{M_3^{(-)}}{M_{n3}^{(-)}} = \frac{1491}{1470} = 1.01$, $\frac{M_3^{(+)}}{M_{n3}^{(+)}} = \frac{974}{791} = 1.23$

BENDING ABOUT VERTICAL AXIS

ASSUME SLAB ACTS AS A DEEP BEAM, ASSUME ONLY STEEL IN OUTER $\frac{L}{6} = 7'$ ACTS IN BENDING, ASSUME COUPLE DISTANCE IS $d_c = 42 - 7' = 35'$

$A_s = 1.26 \text{ in}^2/\text{ft} \times (7') + 0.59 \frac{\text{in}^2}{\text{ft}} (7') = 13.0 \text{ in}^2$

$M'_{n2} = 0.9(13.0)(40)(35) = 16,330$ ft-k

$\frac{M_2}{M_{n2}} = \frac{1133}{16330} = 0.07$

THE MAXIMUM INTERACTION IS
$1.23 + 0.07 = 1.30 < 1.0$

WHILE THIS VALUE IS NOT BELOW 1.0 THE SLAB WILL STILL BE O.K. SINCE THE ACTUAL LOAD IN IT WILL BE MUCH LOWER DUE TO THE LIMITED LOAD IN THE COLUMNS. ALSO THE Z FACTOR IS SO ARBITRARY THAT A LITTLE HIGHER VALUE WOULD HAVE MADE THE INTERACTION FORMULA WORK. FINALLY THIS LOAD ONLY OCCURS IN ONE LOCATION IN THE DECK. ALL OTHER LOCATIONS HAVE VALUES FROM THE INTERACTION BELOW 1.0. THEREFORE, EVEN IF THIS HIGH LOAD COULD OCCUR IT WOULD BE REDISTRIBUTED ALONG THE DECK.

READY

MARGIN #2

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ( | ) | h= | ( | 12 | ) | | | | | | RECTCOL | | |
| | | ( 40 | ) | b= | ( | 480 | ) | | | | | | | | |
| | | ( 3.5 | ) | B1= | ( | 0.85 | ) | | | | COL: | (deck | | | ) |
| | ts : | ksi | | Cb= | ( | 6.17 | ) | | | | | | | | |

| nt | Pu | Mu k-in | Mu k-ft | c | *steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 19875.9 | 0.0 | 0.0 | | * 1 | 2.5 | 50.4 |
| 2 | 14487.1 | 26442.8 | 2203.6 | 10.25 | * 2 | 9 | 23.6 |
| 3 | 1[illegible] | 30066.2 | 2505.5 | 9.08 | * 3 | 0 | 0 |
| 4 | 11193.0 | 32700.1 | 2725.0 | 7.92 | * 4 | 0 | 0 |
| 5 | 10299.0 | 33597.6 | 2799.8 | 7.33 | * 5 | 0 | 0 |
| 6 | 9372.9 | 34240.3 | 2853.4 | 6.75 | * 6 | 0 | 0 |
| 7 | 8405.6 | 34655.4 | 2888.0 | 6.17 | * 7 | 0 | 0 |
| 8 | 7343.3 | 33453.5 | 2787.8 | 5.29 | * 8 | 0 | 0 |
| 9 | 6166.8 | 31061.9 | 2588.5 | 4.41 | * 9 | 0 | 0 |
| 10 | 5081.5 | 27971.4 | 2330.9 | 3.83 | * 10 | 0 | 0 |
| 11 | 699.3 | 12664.9 | 1055.4 | 2.08 | *[PgDn]:factored loads | | |
| 12 | -648.6 | 7617.0 | 634.8 | 1.76 | *F5 HELP [ENTER]: help | | |

neg M

READY

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | s= | ( 29000 | ) | h= | ( | 12 | ) | | | | | | RECTCOL | | |
| | y= | ( 40 | ) | b= | ( | 480 | ) | | | | | | | | |
| | c= | ( 3.5 | ) | B1= | ( | 0.85 | ) | | | | COL: | (deck neg M | | | ) |
| | ts : | ksi | | Cb= | ( | 6.51 | ) | | | | | | | | |

| it | Pu | Mu k-in | Mu k-ft | c | *steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 19875.9 | 0.0 | 0.0 | | * 1 | 3 | 23.6 |
| 2 | 13650.6 | 21990.8 | 1832.6 | 10.35 | * 2 | 9.5 | 50.4 |
| 3 | 11989.6 | 26247.7 | 2187.3 | 9.25 | * 3 | 0 | 0 |
| 4 | 10050.1 | 30234.9 | 2519.6 | 8.16 | * 4 | 0 | 0 |
| 5 | 9014.7 | 31991.6 | 2666.0 | 7.61 | * 5 | 0 | 0 |
| 6 | 7921.8 | 33637.9 | 2803.2 | 7.06 | * 6 | 0 | 0 |
| 7 | 6757.0 | 35224.8 | 2935.4 | 6.51 | * 7 | 0 | 0 |
| 8 | 5757.1 | 34406.4 | 2867.2 | 5.68 | * 8 | 0 | 0 |
| 9 | 4599.0 | 32413.4 | 2701.1 | 4.86 | * 9 | 0 | 0 |
| 10 | 3770.9 | 30527.6 | 2544.0 | 4.31 | * 10 | 0 | 0 |
| 11 | 957.3 | 22015.1 | 1834.6 | 2.66 | *[PgDn]:factored loads | | |
| 12 | -237.8 | 17823.8 | 1485.3 | 2.14 | *F5 HELP [ENTER]: help | | |

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SHEET NO.

NO [illegible] JOB [illegible] BY [illegible] DATE [illegible]

SUBJECT [illegible] CHK'D DATE

CENT CAP

SEE VIADUCT #1 FOR ALLOWANCE

$M_n' = 45,[illegible]$ k (COMPRESSION [illegible] NEGLECTED) REF. 4

MAX. MOMENT OCCURS AT $7i$

$M_{7i} = 920$ [illegible] k $\quad M_{7j} = 618$ [illegible] k

$M_{MAX} = \frac{920}{2} = 460$ [illegible] k $\quad M_{DL} = 3$

$\frac{462}{451} = 1.03 \approx 1.0$ O.K.

$V_{MAX} = 96^k \quad V_{DL} = 1$

$V_n' = 97^k \approx 96$ O.K.

BOTH THE MOMENTS & SHEARS ARE AT THE COLUMN ℄. THE VALUES AT THE FACE OF THE COLUMN WOULD BE SMALLER.

HINGE

REF 4

SEISMIC

$V_{SEIS} = 12^k$, $P_{SEIS} = 102^k$, $V_{TRANS} = 175^k$

REF 3

DL - $V_{VERT} = 46^k$, $P_{LONG} = 3^k$

SINCE DL VERT IS LARGER THAN SEISMIC VERT, UPLIFT WILL NOT OCCUR.

THE AXIAL TENSILE LOAD ACROSS THE HINGE IS $P = 105^k$

THE TOTAL TRANSVERSE SHEAR IS $V = 175^k$

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JOB SF BRIDGES BY GLM DATE

SUBJECT MARKET ST VIADUCT #2 CHK'D DATE

DISPLACEMENTS

REF. 4

$\Delta_{LONGIT} = 2.4'$ <6?

$\Delta_{TRANS.\ MAX} = 4.1''$ AT HINGE

$\Delta_{TRANS.\ AT\ EDGE} = 0.7'$

$\Delta_{TRANS.\ AT\ EDGE\ II} = 0.7'$

[illegible] SEISMIC [illegible] 1989
[illegible] ST [illegible] CHECKED
RESPONSE SPECTRUM ANALYSIS

SHEAR [illegible] 175^k

[illegible] HILTI FASTENERS

ULTIMATE VALUES, BASED ON ABBOTT LABS. TEST REPORT #87532
FOR HILTI FASTENING SYSTEMS, MARCH 24, 1977

IN 2000 psi CONCRETE. 3/4" KWIK-BOLTS, 6" EMBEDMENT
TENSION 13600#
SHEAR 15195#

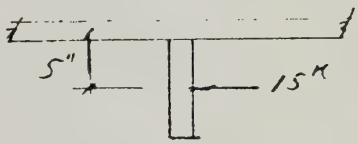
NUMBER REQUIRED = $\frac{175}{15} = 12$

TRANSFER LUGS

ASSUME 6 LUGS:
USE SF = 2.0 FOR LUG DESIGN

$\therefore \quad F = \frac{175}{6 \times 2} = 15^k/\text{LUG}$

$M = 15 \times 5 = 75''^k$
$f_y = 36$ KSI
WIDTH = 6"




$\therefore \quad t = \sqrt{\frac{6M}{bf_s}} = \sqrt{\frac{6 \times 75}{6 \times 36}} = 1.4''$

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SHEET NO. A1
JOB 8438 SF BRIDGE BY GLM DATE
SUBJECT MARKET ST. VIADUCT #3 CHK'D DATE

## REFERENCES


1. COMPUTER OUTPUT 'GLMSISAB2[illegible].OUT' - DEAD LOAD ANALYSIS OF ONE 100' SECTION, 10/16/84

2. COMPUTER OUTPUT 'glmsisab2p3.out' - SEISMIC ANALYSIS OF ONE 100' SECTION, 10/13/84

3. COMPUTER OUTPUT 'GLMSISB23D5.OUT' - DEAD LOAD ANALYSIS OF TWO 100' SECTIONS, 11/6/84

4. COMPUTER OUTPUT 'glmsisb2p3d.out' - SEISMIC ANALYSIS OF TWO 100' SECTIONS, 11/9/84

5. CALCULATIONS FOR MARKET ST. VIADUCT #1 BRIDGE EVALUATION.

6. CITY & COUNTY OF SAN FRANCISCO DEPT OF PUBLIC WORKS DRAWINGS, FILE #'S A-24075, A-24085, A-24087, A-24093, A-24098, A-24089

7. ENGINEERING COMPUTER CORP., 'SEISAB-I' USER MANUAL, JAN. 84.

8. URS/BLUME, "JOB 8438 DESIGN CRITERIA", REV. 1, 6/25/84.

SUPPORTING CALCULATIONS
EVALUATION OF SEISMIC ADEQUACY
HARRISON ST. VIADUCT OVER BEALE ST.

S/BLUME

Jessie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. ii

NO. JOB SF BRIDGE SEISMIC EVALUATION BY DATE 1/4/85

NT SUBJECT HARRISON ST. VIADUCT CHK'D DATE

# INDEX


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SHEET NO. 1

NO. 8438 JOB | BY ERE | DATE 10-24

SUBJECT HARRISON ST. VIADUCT OVER BEALE | CHK'D | DATE

# EVALUATION CALCULATIONS

INTRODUCTION:

CALCULATIONS VERIFYING ADEQUACY OF THE HARRISON ST. VIADUCT OVER BEALE ST. ARE BASED UPON A COMBINATION OF STATIC (D.L. ANALYSIS) + APPROPRIATE LOAD COMBINATIONS OF LONGITUDINAL & TRANSVERSE EARTHQUAKE FORCES. ALL ELEMENTS, EXCEPT TRANSVERSE SHEAR AT THE ABUTMENTS, WERE CHECKED BASED UPON A RESPONSE SPECTRUM ANALYSIS USING 0.5G 10' TO 80' TO BEDROCK SPECTRAL INPUT. THIS DEPTH TO BEDROCK PRODUCES THE HIGHEST ACCELERATIONS IN THE FAMILY OF CALTRANS SPECTRAL CURVES USED AS INPUT FOR THIS INVESTIGATION. ACTUAL DEPTH TO BEDROCK FOR THIS BRIDGE IS IN THE 0 TO 10' RANGE, & A RESPONSE SPECTRUM ANALYSIS USING THE 0 TO 10' DEPTH TO BEDROCK INPUT WAS USED TO CHECK SHEAR AT THE ABUTMENTS, WHICH IS THE ONLY PORTION OF THE BRIDGE INVESTIGATED FOUND TO BE OVER-STRESSED.

ALL SECTION PROPERTIES INPUT ARE BASED UPON UNCRACKED SECTIONS, & IT IS BELIEVED TO PROVIDE SUFFICIENTLY ACCURATE RESULTS. LOAD FACTORS = 1.0 WERE USED WITH ALL EARTHQUAKE LOADS. A LOAD FACTOR OF 1.4 WAS USED WITH STATIC ANALYSIS RESULTS FOR THE SUPERSTRUCTURE DECK ONLY, 1.0 WAS USED ELSEWHERE. (USE OF LOAD FACTORS = 1.0 IS CONSISTENT WITH ATC RECOMMENDATIONS.)

DECK = 9"

MAIN SPAN = 82'-6 (MEASURED INSIDE FACES of ABUTMENTS)

END SPANS:

RIGHT = 45'-0

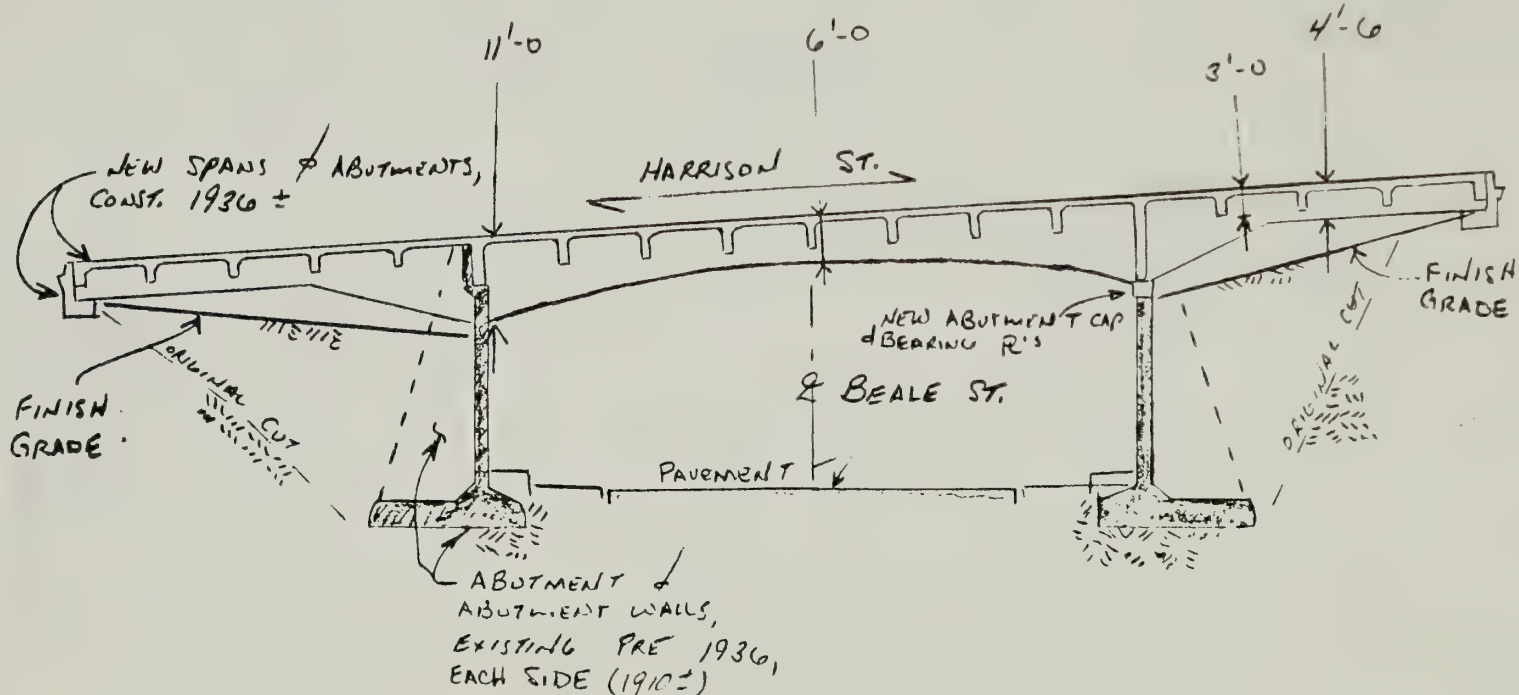
LEFT = 53'-0

ORIGINAL DESIGN FOR EQK: 0.1 g

CONCRETE - 3000 psi & 2500 psi (CLASS A & B)

REINFORCING - 16000 psi WORKING STRESS

} FOR PORTION IMPROVED IN 1936.




LONGITUDINAL SECTION

HARRISON ST. VIADUCT OVER BEALE ST.

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NO. 8438 JOB

SUBJECT HARRISON ST. VIADUCT OVER BEALE ST.

BY SRB DATE 6-14-84

CHK'D DATE

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SHEET NO. 3

a 8438 JOB | BY STB | DATE 6-18-84

SUBJECT HARRISON ST. VIADUCT OVER BEALE ST. | CHK'D | DATE

DEAD LOAD OF DECK

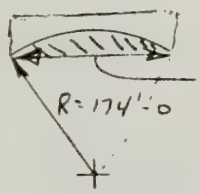
TYP. BEAM: REF A11323

4'-6" × 2'-8" × 53'-0 : 636 FT² × 0.15 = 95^k

(21'-9 − (2'-3")) × (11'-0 − (4'-6")) × 2'-8 : 69.33 FT² × 0.15 = 11^k

2'-3 × 6'-6 × 2'-8 : 39 FT² × 0.15 = 6^k

82'-6 × 11'-0 × 2'-8 : 2420 FT²
− 276 FT²




82'-3 CHORD LENGTH
RISE = 5' $A_{SEG}$ = 276 FT²

A = 2144 FT² × 0.15 = 322^k

2'-3 × 6'-6" × 2'-8 : 39 FT² × 0.15 = 6^k
(6'-6) × 14'-6 × 2'-8 : 251 FT² × 0.15 = 38^k
28'-3 × 4'-6 × 2'-8 : 339 FT² × 0.15 = 51^k

529^k

TRANSVERSE BEAMS & SLAB:

TYP. 1'-3 × 3'-0 × 14'-7½ = 54.84 FT³
9'-3 × 14'-7½ × 9" = 101.5 FT³
156.3 FT³

14 @ 156.3 FT³ = 2188. FT³
2 @ 54.84 + 101.5/2 = 211.1
2 @ 101.5 = 203.

20 @ 12" × 11' × 14'-7½ = 321.75
2924. FT³
× 4 = 11695. FT³
× 0.15 = 1754.^k

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SHEET NO. 4

JOB

BY STB DATE 6-18-84

SUBJECT HARRISON ST. VIADUCT OVER BEALE ST.

CHK'D DATE

SIDEWALK GIRDERS & SLAB

Typ. 1'-3 × 9'-6 × 3'-11½ = 12.37 FT³
5" × 9'-3 × 3'-11½ = 15.26 FT³
27.63 FT³

14 @ 27.63 = 386.82 FT³
2 @ 12.37 + 15.26/2 = 40.
2 @ 15.26 = 30.52
457.34

× 2 SIDES = 914.7 FT³
× 0.15 = 137.^K

BEAM @ OUTBOARD SIDES

(1'-9 × 1'-5 + 1'-0 × 1'-6) × 180'-6" = 718.24 FT³
× 2 SIDES
= 1436.5 FT³
× 0.15 = 215.^K

DEAD LOAD ON DECK - TOTAL

529
1754.
137
215
2635.^K

DEAD LOAD OF ABUTMENTS: (EACH) <SEE FIGURE ON FOLLOWING SHT.

Top QUARTER:

WALL - $2'-0 \times 9'-9\frac{1}{2}'' \times 82'-6 \times 0.15 = 242^k$

BUTTRESSES - $\frac{10''+4'-0}{2} \times 9'-9\frac{1}{2}'' \times 18'' \times 11 \text{ walls} \times 0.15\ k/ft^3 = 59^k$

$301^k$

Top MID QUARTER:

WALL - $242^k$

BUTTRESS $\frac{4'-0 + 7'-2}{2} \times 9'-9\frac{1}{2}'' \times 18'' \times 11 \times .15 = 136^k$

$378^k$

BOTTOM MID QUARTER:

WALL - $242^k$

BUTTRESS $\frac{7'-2 + 10'-4}{2} \times 9'-9\frac{1}{2} \times 18'' \times 11 \times .15 = 212^k$

$454^k$

BOTTOM QUARTER:

WALL (THROUGH FTG) - $242^k$

REMAINDER of FOUNDATION -

$\frac{20''+30''}{2} \times 6'-6 \times 82'-6 \times 0.15 = 168^k$

$30'' \times 11'-6 (\pm) \times 82'-6 \times 0.15 = 356^k$

BUTTRESS: $5.63' \times 11.24' \times 18'' \times 0.15 = 14^k$

$780^k$

SUMMARY - ABUTMENT DEAD LOAD

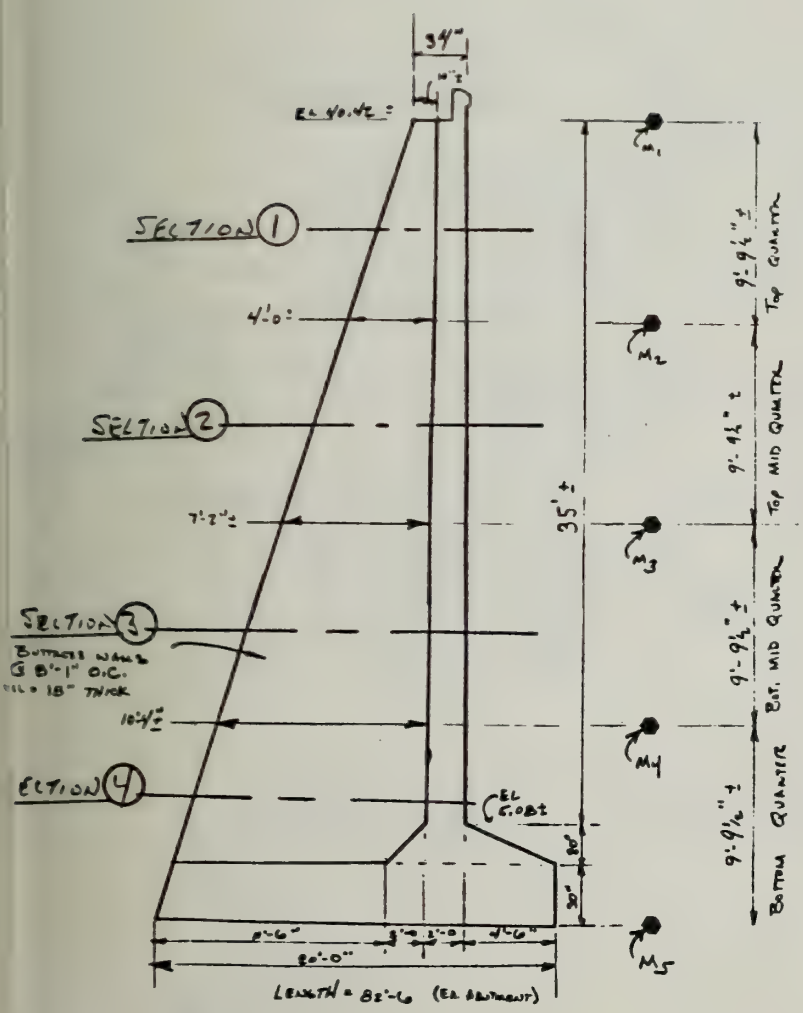
$M_1 = 301 \div 2 = 150.5^k$

$M_2 = (301 + 378) \div 2 = 339.5^k$

$M_3 = (378 + 454) \div 2 = 416.^k$

$M_4 = (454 + 780) \div 2 = 617^k$

$M_5 = 780 \div 2 = 390^k$




PRE-EXISTING ABUTMENTS
CONSTRUCTED ~ 1910
NTS

TRIBUTARY DEAD LOAD FROM ABUTMENT ONLY

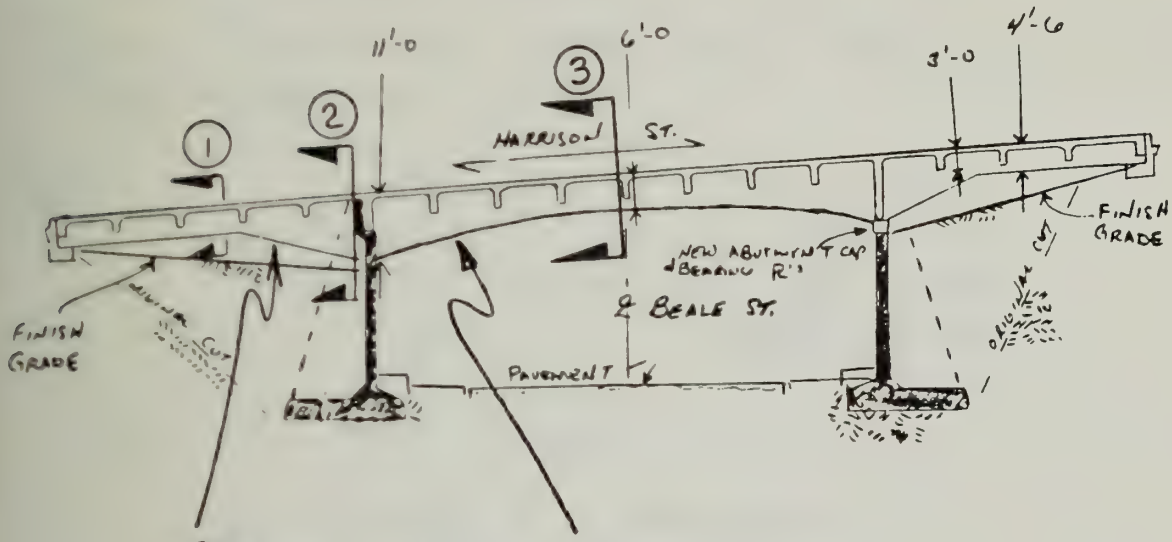
$150.5^k$

$339.5^k$

$416^k$

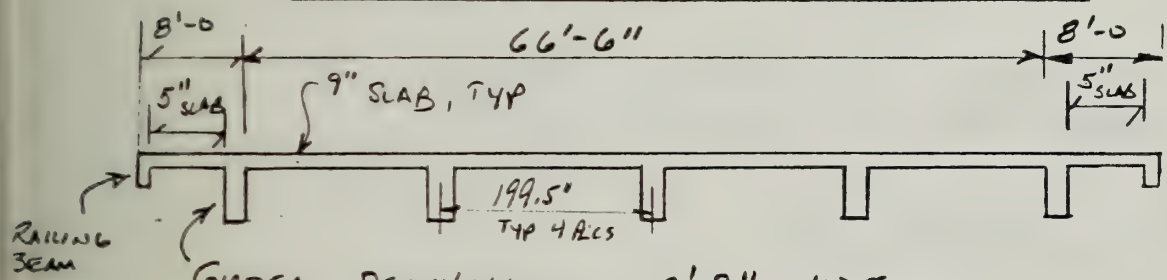
$617^k$

$390^k$




STRAIGHT LINE PARABOLIC CURVE

LONGITUDINAL SECTION




GIRDER, DEPTH VARIES ; 2'-8" WIDE

4'-6 @ SECTION 1
11'-0 @ SECTION 2
6'-0 @ SECTION 3
} DEPTH

SECTIONS 1, 2 & 3

NTS

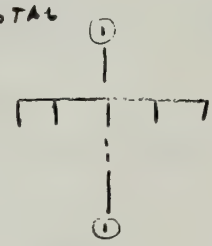
## SECTION PROPERTIES OF DECK

USE 9" SLAB + MAIN GIRDERS ONLY (NEGLECT 5" SLAB + RAILING BEAMS)
TYP ALL SECTIONS

### SECTION 1

AREA = $\overset{798''}{(66'-6'')} \times 9''$ = 7182. $in^2$ SLAB
$+ \underbrace{((4'-6'')-9'')}_{45''} \times \underbrace{(2'-8'')}_{32''} \times 5$ = 7200. GIRDERS
A = 14382. $in^2$ TOTAL

$I_{11}$: IN PLANE MOMENT OF INERTIA



SLAB: $\frac{(798'')^3 \times 9}{12}$ = 381,127,194. $in^4$

GIRDERS: $5 \times \frac{(32'')^3 \times 45''}{12}$ = 614,400. $in^4$

$2 \times (1440\ in^2) \times (199.5\ in)^2$ = 114,624,720. $in^4$
$2 \times (1440\ in^2) \times (399\ in)^2$ = 458,498,880. $in^4$

$I_{11}$ = $9.5486 \times 10^8$ $in^4$

$I_{22}$:

$\bar{Y} = \left[(7182.\ in^2) \times \frac{9''}{2} + (7200\ in^2) \times \left(\frac{45''}{2} + 9''\right)\right] \times \frac{1}{14382}$

$\bar{Y}$ = 18.02" SAY 18"

SLAB: $(798'') \times \frac{(9)^3}{12} + 7182 \times (13.5'')^2$ = 1,357,398. $in^4$

GIRDERS: $\left\{(32'')\frac{(45)^3}{12} + 1400\ (13.5'')^2\right\} \times 5$ = 2,490,750. $in^4$

$I_{22}$ = 3,848,148. $in^4$

## SECTION 2

$$A = 7182 + (\underbrace{32'' \times (\overbrace{132'' - 9''}^{123''})}_{3936\ in^2}) \times 5 = 26862.\ in^2$$

$I_{11}$: SLAB: 381,127,194. $in^4$

GIRDERS $(32^3 \times 123'' \div 12) \times 5 = 1,679,360.\ in^4$

$2 \times 3936 \times 199.5^2 = 313,307,568.$

$2 \times 3936 \times 399.^2 = 1,253,230,272.$

$$I_{11} = 1.9493 \times 10^9\ in^4$$

$I_{22}$:

$$\bar{Y} = \left(7182 \times \frac{9}{2} + 3936 \times 5 \times \left(\frac{123}{2} + 9\right)\right) \div 26862 = 52.85''$$

SAY 53"

SLAB: $798 \times \frac{9^3}{12} + 7182 \times 48\tfrac{1}{2}^2 = 16\,492\,338.$

GIRDERS: $\left(32 \times \frac{123^3}{12} + 3936 \times 17.5^2\right) \times 5 = 30\,838\,560.$

$$I_{22} = 4.7781 \times 10^7\ in^4$$

## SECTION 3

$$A = 7182 + (\overbrace{32'' \times 63''}^{2016\ in^2}) \times 5 = 17262.\ in^2$$

$I_{11}$: SLAB: 381,127,194. $in^4$

GIRDERS: $(32^3 \times 63'' \div 12) \times 5 = 860,160.\ in^4$

$2 \times 2016 \times 199.5^2 = 160,474,608.$

$2 \times 2016 \times 399^2 = 641,898,432.$

$$I_{11} = 1.1844 \times 10^9\ in^4$$

$I_{22}$:

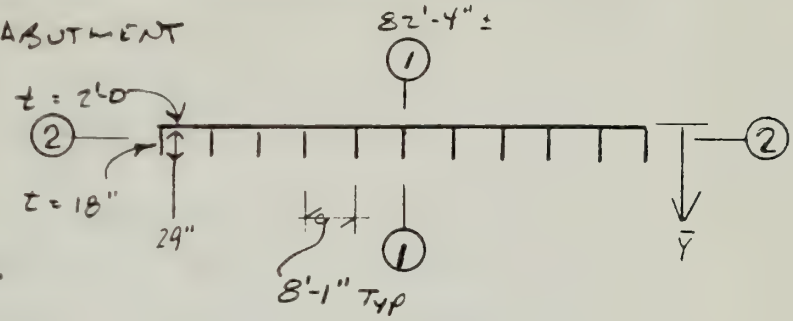
$$\bar{Y} = \left(7182 \times \frac{9}{2} + 2016 \times 5\left(\frac{63}{2} + 9\right)\right) \div 17262. = 25.5''$$

SLAB: $798 \times 9^3/12 + 7182 \times 21^2 = 3,215,740.\ in^4$

GIRDERS: $\left(32 \times \frac{63^3}{12} + 2016 \times 15^2\right) \times 5 = 5,601,960.\ in^4$

$$I_{22} = 8.8177 \times 10^6\ in^4$$

ELASTIC PROPERTIES of ABUTMENT




SECTION 1

$A = 24 \times 988 + 11 \times 18 \times 29$
$= 23712. + 5742 = 29454.$

$I_{11}$:

WALL: $2'\text{-}0 \times 82'\text{-}4$

$24" \times (988")^3 \times 1/12 = 1{,}928{,}860{,}544.$
$1.9289 \times 10^9$ in$^4$

BUTTRESSES:

$(18")^3 \times 29" \times 1/12 \times 11 = 155034.$ in$^4$

$Ad^2 = 2 \times (18 \times 29)(8.8033^2 + (2 \times 8.08)^2 + (3 \times 8.08)^2 + (4 \times 8.08)^2 + (5 \times 8.08)^2)$
$= 3593.72$ ft$^2$
$\times 144 = 517495.$ in$^2$

$Ad^2 = 2 \times 18 \times 29 \times 517495 = 5.4026 \times 10^8$ in$^4$

$I_{11} = 2.4693 \times 10^9$ in$^4$

$I_{22}$:

$\bar{Y} = (23712 \times 12" + 5742 \times 38.5") \times \frac{1}{29454} = 17.17"$
SAY 17"

WALL: $(24)^3 \times 988 \times 1/12 + 23712 \times (5")^2 = 1.731 \times 10^6$ in$^4$

BUTTRESS: $18 \times (29)^3 \times 1/12 \times 11 + 5742(19.5)^2 = 2.5858 \times 10^6$ in$^4$

$I_{22} = 4.3168 \times 10^6$ in$^4$

SECTION ②

$$A = 23712 + \overset{13266}{11 \times 18 \times 67''} = 36978.\ in^2$$

$I_{11}$: WALL $1.9289 \times 10^9\ in^4$

BUTTRESS: $(18'')^3 \times 67'' \times 1/12 \times 11 = 358182$

AJ' $2 \times 18 \times 67 \times (517495.\ in^2) = 1.2480 \times 10^9\ in^4$

$$I_{11} = 3.1773 \times 10^9\ in^4$$

$I_{22}$:

$$\bar{Y} = (23712 \times 12'' + 13266 \times 57.5'') \times \frac{1}{36978} = 28.32''$$

SAY 28¼"

WALL- $24^3 \times 988 \times 1/12 + 23712 \times 16.25^2 = 7.3996 \times 10^6\ in^4$

BUTTRESS: $18 \times 67^3 \times 1/12 \times 11 + 13266 \times (29.25'')^2 = 14.057 \times 10^6\ in^4$

$$I_{22} = 21.456 \times 10^6\ in^4$$

SECTION ③

$$A = 23712 + \overset{20790}{11 \times 18'' \times 105''} = 44502.\ in^2$$

$I_{11}$: WALL- $1.9289 \times 10^9\ in^4$

BUTTRESS: $(18)^3 \times 105'' \times 1/12 \times 11 = 561330$

AJ' $2 \times 18 \times 105 \times (517495.\ in^2) = 1956131100.$

$$I_{11} = 3.8856 \times 10^9\ in^4$$

$I_{22}$: $\bar{Y} = (23712 \times 12'' + 20790 \times 76.5'') \div 44502. = 42.13''$

SAY 42"

WALL- $24^3 \times 988 \times 1/12 + 23712 \times 30^2 = 22.479 \times 10^6$

BUTTRESS: $18 \times 105^3 \times 1/12 \times 11 + 20790 \times 34.5^2 = 43.846 \times 10^6$

$$I_{22} = 66.325 \times 10^6\ in^4$$

SECTION (4)

$A = 23712 + 28314 \quad 11 \times 18 \times 1\tfrac{1}{3}'' = 52026.\ in^2$

$I_{11}$ : WALL $\quad 1.4289 \times 10^9\ in^4$

BUTTRESS $\quad 18^3 \times 1\tfrac{1}{3} \times \tfrac{1}{12} \times 11 = 76478.\ in^4$

ADD – $\quad 2 \times 18 \times 1\tfrac{1}{3} \times 517495 = 2.6641 \times 10^9\ in^4$

$I_{11} = \underline{\underline{4.5937 \times 10^9\ in^4}}$

$I_{22}$ : $\bar{Y} = (23712 \times 12 + 28314 \times 95.5) \div 52026 = 57.44''$

SAY $57\tfrac{1}{2}''$

WALL : $24^3 \times 988 \times \tfrac{1}{12} + 23712 \times 45.5^2 = 50.228 \times 10^6$

BUTTRESS : $18 \times 1\tfrac{1}{3}^3 \times \tfrac{1}{12} \times 11 + 28314 \times 38^2 = 89.135 \times 10^6$

$I_{22} = \underline{\underline{139.36 \times 10^6}}$

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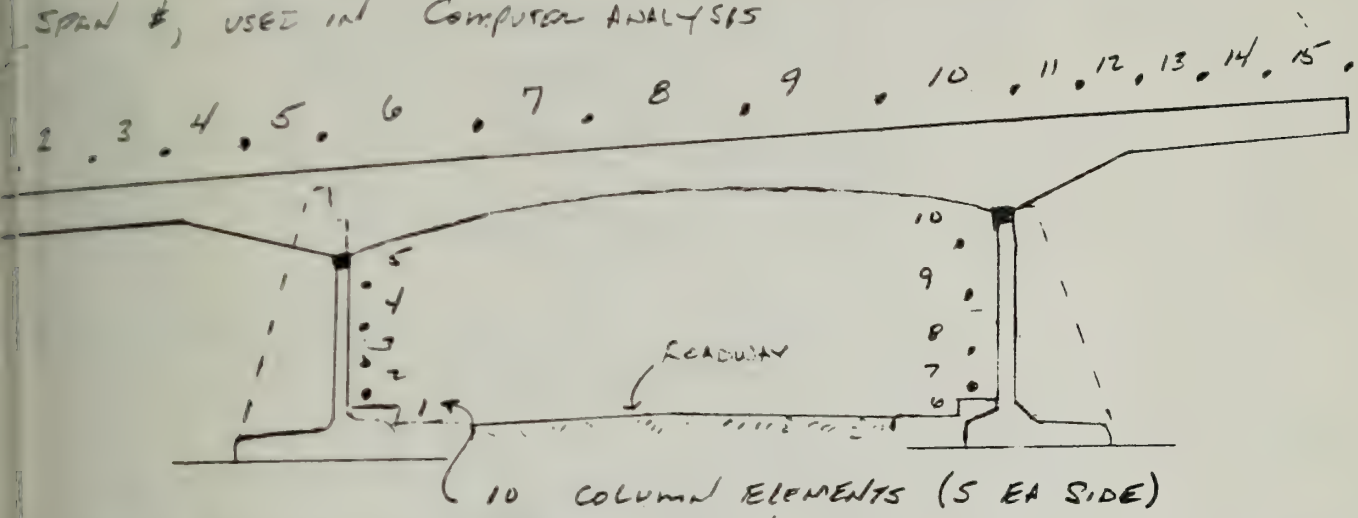
JOB B/3B BY STB DATE 10-1-84

SUBJECT HARRISON ST. VIADUCT OVER BEALE ST. CHK'D DATE

SPAN #, USED IN COMPUTER ANALYSIS




SPAN ELEMENTS, BASED ON 4 INTERMEDIATE JOINTS ON EA SPAN

SPAN ELEMENTS, RESPONSE SPECTRUM ANALYSIS

| ELM'S | LOAD CASE | INTERNAL FORCES | | | | |
|---|---|---|---|---|---|---|
| | | AXIAL | $V_2$ | $V_3$ | $M_2$ | $M_3$ |
| 1,3 | L | 96.1 | 13.9 | 0 | 0 | 125.8 |
| | T | 0 | 0 | 144.3 | 42872. | 0 |
| 4,5 | L | 152.4 | 28.7 | 0 | 0 | 519.6 |
| | T | 0 | 0 | 1126.7 | 64317. | 0 |
| 6 | L | 136.7 | 229.8 | 0 | 0 | 3441. |
| | T | 0 | 0 | 893.5 | 79473. | 0 |
| 7,8,9 | L | 92.8 | 153.8 | 0 | 0 | 1329. |
| | T | 0 | 0 | 531.4 | 87060. | 0 |
| 10 | L | 78.4 | 228.3 | 0 | 0 | 3334. |
| | T | 0 | 0 | 95.06 | 77604. | 0 |
| 11,12 | L | 162.9 | 92.5 | 0 | 0 | 1558. |
| | T | 0 | 0 | 1320. | 61686. | 0 |
| 13-15 | L | 99.1 | 53.3 | 0 | 0 | 453.4 |
| | T | 0 | 0 | 1554. | 39698. | 0 |
| | | R=1.0 | R=1.0 | R=1.0 | R=3.0 | R=3.0 |

CALTRANS SPECTRA, 10 to 80 FT TO BEDROCK, A = 0.5 G

(BSELSAB1A.OUT
10-1-84)

SPAN ELEMENTS - STATIC ANALYSIS

| SPANS | LOAD CASE | INTERNAL FORCES | | | | |
|---|---|---|---|---|---|---|
| | | AXIAL | $V_2$ | $V_3$ | $M_2$ | $M_3$ |
| 1 to 3 | * | 32.0 | 260. | 0 | 0 | 1704. |
| 4 & 5 | * | 53.5 | 599.2 | 0 | 0 | 9141. |
| 6 | * I S | 96.6 | 690.8 | 0 | 0 | 12281. 2914. |
| 7, 8, 9 | * | 79.1 | 415.3 | 0 | 0 | 2915. |
| 10 | * I S | 26.9 | 686.7 | 0 | 0 | 2812. 12109 |
| 11, 12 | * | 45.3 | 501.1 | 0 | 0 | 6284. |
| 13, 14, 15 | * | 27.2 | 216. | 0 | 0 | 1280.5 |

* LOAD CASE = STATIC DEAD LOAD

(STG STATIC1. OUT
9-18-84)

## SPAN DESIGN CHECK

### SPANS 1, 2, 3

L.E. = LONGITUDINAL EQK
T.E. = TRANSVERSE EQK

2 LOAD CASES OF INTEREST
(1) 1.4D + 1.0 L.E. + 0.3 T.E.
(2) 1.4D + 0.3 L.E. + 1.0 T.E.

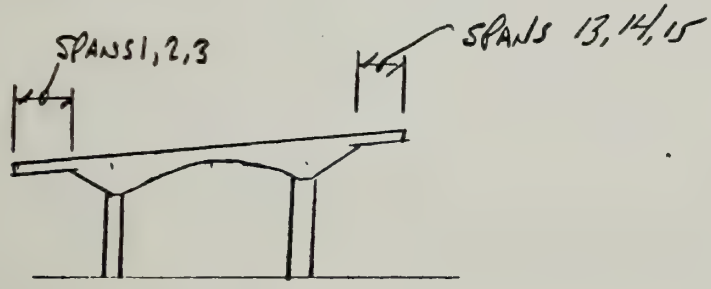
**LOAD CASE (1)** SPANS 1,2,3

| | | * (R=1.0) | R=2.0 | R=3.0 |
|---|---|---|---|---|
| $P = 1.4 \times 32 + 96.1 + 0$ | = | $140.9^k$ | — | — |
| $V_2 = 1.4 \times 260 + 13.9 + 0$ | = | $275.3^k$ | — | — |
| $V_3 = 0 + 0 + 0.3(144.3)$ | = | $43.3^k$ | — | — |
| $M_2 = 0 + 0 + 0.3(14291)$ | = | $4287^{k'}$ | $2144.^{k'}$ | 1429. |
| $M_3 = 1.4 \times 1704 + 41.93 + 0$ | = | $2427.5^{k'}$ | 2406. | 2511. |

**LOAD CASE (2)** SPANS 1,2,3

| | | * (R=1.0) | R=2.0 | R=3.0 |
|---|---|---|---|---|
| $P = 1.4 \times 32 + 0.3(96.1) + 0$ | = | $73.6^k$ | — | — |
| $V_2 = 1.4 \times 260 + 0.3(13.9) + 0$ | = | $368.2^k$ | — | — |
| $V_3 = 0 + 0 + 144.3$ | = | $144.3^k$ | — | — |
| $M_2 = 0 + 0 + 14291$ | = | $14291.^{k'}$ | 7145 | 4764 |
| $M_3 = 1.4 \times 1704 + 0.3(41.93) + 0$ | = | $2398.^{k'}$ | ~~2398~~ | ~~2398~~ |

* W/o REDUCTION FACTOR "R" DESIGN LOAD = $D + \frac{EQK}{\text{"}R\text{"}}$



GAN DESIGN CHECK (CONT'D) SPANS 13, 14, 15

LOAD CASE 1 SPANS 13, 14, 15

| | | * (R=1.0) | R=2.0 | R=3.0 |
|---|---|---|---|---|
| $P = 1.4 \times 27.2 + 99.1 + 0$ | = | $137.2^k$ | — | — |
| $V_2 = 1.4 \times 216 + 53.3 + 0$ | = | $355.7^k$ | — | — |
| $V_3 = 0 + 0 + 0.3(1544)$ | = | $463.2^k$ | — | — |
| $M_2 = 0 + 0 + 0.3(39698)$ | = | $11909.^{k'}$ | 5955 | 3970 |
| $M_3 = 1.4 \times 1280.5 + 453. + 0$ | = | $2246.^{k'}$ | 2019 | 1943. |

LOAD CASE 2 SPANS 13, 14, 15

| | | * (R=1.0) | R=2.0 | R=3.0 |
|---|---|---|---|---|
| $P = 1.4 \times 27.2 + 0.3(99.1) + 0$ | = | $67.8^k$ | — | — |
| $V_2 = 1.4 \times 216 + 0.3 \times 53.3 + 0$ | = | $318.4^k$ | — | — |
| $V_3 = 0 + 0 + 1554.$ | = | $1554.^k$ | — | — |
| $M_2 = 0 + 0 + 39698$ | = | $39698.^{k'}$ | 19849 | 13232 |
| $M_3 = 1.4 \times 1280.5 + 0.3(453.) + 0$ | = | $1928.6^{k'}$ | 1861. | 1838. |

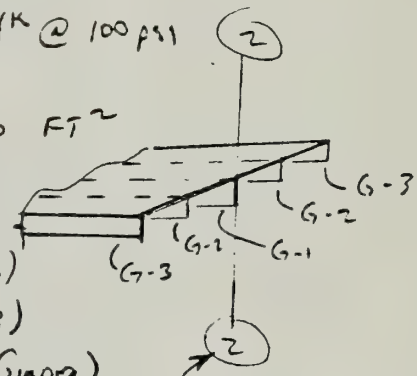
* W/O REDUCTION FACTOR "R", DESIGN FORCE = $D + \frac{EQ^k}{"R"}$

DESIGN Check Cont'd:

SPANS 1, 2, 3

156.4 in² (STEEL) (T) 5630^K @ Fy

- AXIAL AREA = 14382 in² = 100. FT² (CONCRETE)(C) 36000^K @ f'c
- SHEAR AREA (2)
  USE 4'-6" x 2'-8" x 5 BEAMS = 60 FT²
  864^K @ 100 psi
- SHEAR AREA (3)
  USE 9" x 79.8" = 7182 in² = 50 FT²
  720^K @ 100 psi
- MULT. (2):
  TOTAL WIDTH = 71'-10" (To use structurally)
  OUT TO OUT, OUTSIDE GIRDERS (G-3)
  TOTAL DEPTH = 4'-6" (Top of Slab To Bott. of Girder)




AXIS ORIENTATION, COMPUTER ANALYSIS.

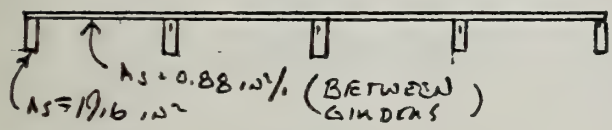
$A_s$ GIRDER G-3: 4 - 1¼ □ BOTT
12 - 1¼ □ top } @ CRIT SECT (SPAN 3)
$A_s$ GIRDER = 19.6 in²

1¼" □ = 1.23 in²

Typ FOR G-2 & G-3 ALSO.

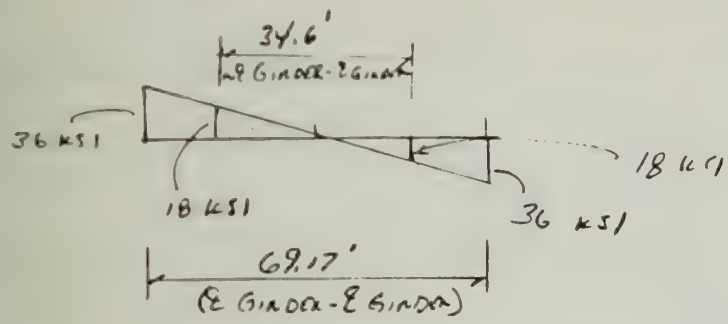
Typ. ROADWAY SLAB 3/4" ϕ @ 12" o.c. top
3/4" ϕ @ 6" o.c. BOTT

USE 2 - 3/4" ϕ @ 12" o.c. FOR $A_{s_{SLAB}}$ (SLAB = 9")
or
$A_{SLAB}$ = 0.88 in²/FT



DESIGN CHECK - CONT'D

ANS 1.2.3 USE A FAIRLY CRUDE APPROX. - STEEL-STEEL COUPLE ONLY.




$M_{G-3} = 36\ ksi \times 19.6\ in^2 \times 69.17' = 48\,806.\ k'$

$M_{G-2} = \cancel{36}\ 18\ ksi \times 19.6\ in^2 \times 34.6' = \cancel{24\,413.\ k'}$ 12200

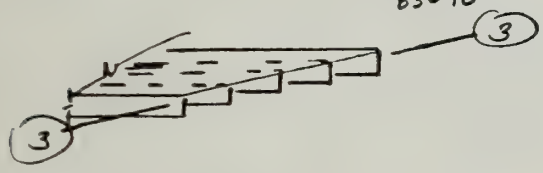
$M_{SLAB} = \begin{cases} 27\ ksi \times 14.6\ in^2 \times 51.8' = 20\,484.\ k' \\ 9\ ksi \times 14.6\ in^2 \times 17.3' = 2\,273.\ k' \end{cases}$

$\cancel{95\,911.\ k'}$ 83698

61 000
$\cancel{73220\ k'}$
℄ GIRDERS ONLY

USE $M_{ULT}(7) = \cancel{95\,911\ k'}$ 83698

- $M_{ULT}(3)$




GIRDER G-1, G-2, G-3.

$A_{ST\ TOP} = 12 \cdot 1\tfrac{1}{4}\square = 14.7\ in^2$ / PER GIRDER

$A_{ST\ BOTT} = 4 - 1\tfrac{1}{4}\square = 4.9\ in^2$ / PER GIRDER

WEAKEST DIRECTION IS W/ 4 - 1¼" □ BARS IN TENSION (+ MOMENT)

$d_{STL-STL} = (4'-6") - 2" - 3" - 1\tfrac{1}{4}" = \text{SAY } 4'-0$

(COMP. STEEL As > TENS. STEEL As)

$M = 36\ ksi \times 4.9\ in^2 \times 4'-0 = 707^{k'}$ PER GIRDER

$707^{k'} \times 5$ GIRDERS $= \underline{3534.^{k'}}$

USE $M_{ULT}(3) = 3534^{k'}$

DESIGN CHECK CONT'D SPANS 1,2,3 & 13,14,15

SPANS 1,2,3 CASE 1

$P = 140.9^k$ — 5630$^k$ STEEL, 36000$^k$ CONC. — AXIAL ok

$V_2 = 275.3^k$ — $864 \times 0.8 = 691$; $275.3/691 = 0.40$

$V_3 = 43.3^k$ — $720 \times 0.8 = 576^k$; $43.3/576 = 0.08$

SHEAR ok

$M_2$ — $R = 1.0$, $4287^{k'}$ — 83698 ~~95411~~ $\times .9 =$ ~~86319~~ $^{k'}$ $75000^{k'}$; $4287/$~~86319~~ 75000 $= 0.05$ (ok)

$M_3$ — $R = 1.0$, $2427.5^{k'}$ — $3534^{k'} \times 0.9 = 3180^{k'}$; $2427.5/3180 = 0.76$

$0.05 + 0.76 = 0.81 < 1.0$ ok (ok)

$(\omega/R = 1.0)$

SPANS 1,2,3 CASE 2

$P = 73.6$ — ok

$V_2 = 368.2$ — $368.2/691 = 0.53$

$V_3 = 144.3$ — $144.3/576 = 0.25$

ok

R=1.0 { $M_2 = 14291.$ — $14291./$~~86319~~ 75000 $=$ ~~0.17~~ 0.19; $M_3 = 2398$ — $2398/3180 = 0.75$ } ~~0.92~~ 0.94 $< 1.0$ ok

ESIGN CHECK CONT'D

SPANS 13, 14, 15 CASE 1

$P = 137.2^k$ ok

$V_2 = 355.7^k$ $355.7/691 = 0.51$ } NO ACCOUNT FOR SHEAR FRICTION — OK

$V_3 = 463.2^k$ $463.2/576 = 0.80$

$R = 1.0$ { $M_2 = 11909$ $11909/\cancel{86319}\ 75000 = \cancel{0.14}\ 0.16$ } $\cancel{0.84}$ $0.87$ ✓ c/w ok

$M_3 = 2246$ $2246/3180 = 0.71$

SPANS 13, 14, 15 CASE 2

$P = 67.8$ ok

$V_2 = 318.4$ $318.4/691 = 0.46$ ok SEE BELOW

$V_3 = 1554.$ $1554/576 = 2.70$ ← ~~PROBLEM~~

$R = 1.0$ { $M_2 = 39698.^{k'}$ $39698/\cancel{86319}\ 75000 = \cancel{0.46}\ 0.53$ } $\cancel{1.07}$ $1.4$ ✓ (CAN USE $R = 3.0$, OK).

$M_3 = 1929.^{k'}$ $1929/3180 = 0.61$

COMPUTE SHEAR FRICTION AVAILABLE FOR $V_3$: (RQ'D TO CK CASE 2)

$V_n = A_{vf}\, \phi f_y \mu$

$\mu = 1.4$

$f_y$ = GR 40, 40 KSI

$\phi = 0.85$

$V_n = \underline{2780^k}$

LIMIT TO 800 PSI

$A_{vf} = 14.6\ in^2 \times 4$ (CONSERVATIVE)

$9'' \times 69' (\times 12) \times .8\ KSI = 5962^k$ ok

$V_n = 2780^k >> 1554$ ok

Check spans 4, 5, 6 check @ Section 6 (RHS, end "J")
10, 11, 12

16.5' into cntr span.

Spans 4, 5, 6 &, 10, 11, 12 (CK worst case each force component)

CASE 1

$P = 1.4 \times 96.6 + 162.9 + 0 = 298.^{K}$

$V_2 = 1.4 \times 691. + 229.8 + 0 = 1197.^{K}$

$V_3 = 0 + 0 + 0.3(1320.) = 396.^{K}$

$M_2 = 0 + 0 + 0.3(79473.) = 23842^{K'}$

$M_3 = 1.4 \times 12281 + 3441. + 0 = 20634^{K'}$ — (moment @ support)

@ support

$M_3 = 1.4 \times 2914 + 599 = 4678^{K'}$

@ interior

CASE 2

$P = 1.4 \times 96.6 + 0.3(162.9) + 0 = 184.1^{K}$

$V_2 = 1.4 \times 691. + 0.3(229.8) + 0 = 1036.^{K}$

$V_3 = 0 + 0 + (1320.) = 1320.^{K}$

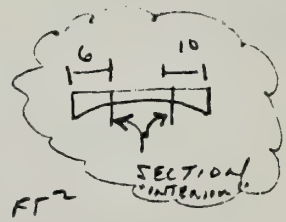
$M_2 = 0 + 0 + 79473 = 79473.^{K'}$

$M_3 = 1.4 \times 12281 + 0.3(3441) + 0 = 18196.^{K'}$ - (moment @ support)

@ support

$1.4 \times 2914 + 0.3(599) + 0 = 4260^{K'}$

@ interior




Interior span properties @ sections 6 & 10:

(axial) Area: Slab: 9" × 58.5' = 43.9 ft²

Girders: 7½' × 2'-8 × 5 = 100 ft²

144 ft² concrete

Reinf. steel:

Slab: 0.88 in²/ft × 58.5' = 51.5 in²

Girders: 14 @ 1¼" □ × 5 girders = 86.1 in² × 36 ksi = 4953^K

137.6 in² Reinf. steel.

Shear area (2) 7½' × 2'-8" × 5 girders = 100 ft²
(440^K @ 100 psi) (no ϕ)

Shear area (3) 9" × 798" → 50 ft²
(720^K @ 100 psi no ϕ)

INTERIOR SPAN PROPERTIES @ SECTIONS 6 & 10, CONT'D

← ELEMENT 6 END J, ELMT 10 END I

M (3): 6 - 1¼"□ TOP } OVERALL DEPTH = 7½'
8 - 1¼"□ BOTT

USE FORCE COUPLE OF 6 BARS, 7'-0 = MOMENT ARM

1.23 in² × 6 BARS × 36 KSI × 7' × 5 GIRDERS = 9300 k'

INTERIOR

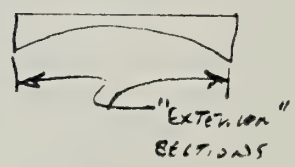
(2) M(2): 14-1¼"□ BARS = 17.22 in²

36 KSI × 17.22 in² × 69.17' = 42880 k'
18 KSI × 17.22 × 34.6' = 10725.
27 KSI × 14.6 in² × 51.8' = 20420.
74,000. k'

EXTERIOR SPAN PROPERTIES @ SECTIONS 6 & 10 (MOMENT ONLY)

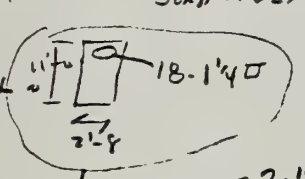
← ELEMENT 6 END I, ELMT 10 END J

DEPTH = 11'-0
22 - 1¼"□ TOP
4 - 1¼ BOTT.




M(2): MUCH LARGER THAN CALC. ABOVE - OK

M(3) (+) 4 - 1¼"□ 36KSI×1.23×4 BARS × 10.5' × 5 GIRDERS = 9300 k'

(-) 9300 k' + 


d ≈ 10'-8

a ≈ 22.14×36 / .85(2.5)(32) = 11¾" VALID FOR SINGLY REINF SECTION

CONSERVATIVELY USE MOMENT ARM = 8½'

M3(-) = 9300 + 22.14 × 36 KSI × 8½' × 5 GIRDERS = 43174 k'

CHECK WORST OF CASE 1 / 2 (SPANS 4, 5, 6, 10, 11, 12)

$P$: 298$^k$ ok

$V_2$: 1197$^k$ < 1440$^k$ x.85 = 1224$^k$ ok

$V_3$: 1320$^k$ > 720$^k$ BUT DOES NOT INCLUDE SHEAR FRICTION - SEE BELOW

$M_2$: 79473$^{k'}$ > 74000$^{k'}$ x.9 (66,600) BUT 79473 IS FOR R=1, R=3 IS ACCEPTABLE ok

* $M_3$ INTERIOR = 4678.$^{k'}$ < 9300$^{k'}$ x.9 = 8370 ok (79493÷3) < 66,600$^{k'}$ ok.

$M_3$ EXT. (+) = -13757. (IE (-) m) — DOESN'T GOVERN, USE $M_{3\,EXT}$(-).

$M_3$ EXT. (-) = 20634$^{k'}$ < 43174$^{k'}$ x.9 = 38857 ok

SHEAR FRICTION, $V_3$ ALLOW = 2780$^k$, (SEE PREV. SHTS). 2780 >> 1320 ok

∴ SPANS 4, 5, 6, 10, 11, & 12 MEET CRITERIA.

ok

* MOMENT INTERACTION $\simeq \dfrac{79493 \div 3}{66{,}600} + \dfrac{20634}{38857} = 0.93 < 1.0$ ok

0.4 0.53

SPANS 7, 8, 9

(1.4D + 1.0 LE + 0.3 TE)

CASE 1

| | | | | R=1 | R=2 | R=3 |
|---|---|---|---|---|---|---|
| $P$ = | 1.4 x 79.1 | + 92.8 | + 0 | = 203.5 k | — | — |
| $V_2$ = | 1.4 x 415.3 | + 153.8 | + 0 | = 735.2 k | — | — |
| $V_3$ = | 0 | + 0 | + 0.3(531.4) | = 159.4 k | — | — |
| $M_2$ = | 0 | + 0 | + 0.3(87060) | = 26118 k' | 13059 | 8706 |
| $M_3$ = | 1.4 x 2915. | + 1329 | + 0 | = 5410 k' | 4746 | 4524 |

CASE 2 (1.4D + 0.3 LE + 1.0 TE.)

| | | | | | R=2 | R=3 |
|---|---|---|---|---|---|---|
| $P$ = | 1.4 x 79.1 | + 0.3(92.8) | + 0 | = 138.6 | | |
| $V_2$ = | 1.4 x 415.3 | + 0.3(153.8) | + 0 | = 627.6 | | |
| $V_3$ = | 0 | + 0 | + 531.4 | = 531.4 | — | — |
| $M_2$ = | 0 | + 0 | + 87060 | = 87060. | 43530 | 29020 |
| $M_3$ = | 1.4 x 2915 | + 0.3(1329) | + 0 | = 4480 | 4280 | 4214 |

SPAN PROPERTIES @ CENTER, (DEPTH = 6'-0)

AXIAL AREA - CONC (SLAB: 43.9 FT²
GIRDERS: 6' x 2'-8 x 5 = 40.
84 FT²

REINF STEEL (SLAB: 0.88 IN²/FT = 51.5 IN²
GIRDERS: 24 - 1'4" □ x 5 GIRDERS → 147.6 IN²
199.1 IN²

SHEAR AREA (2): 6' x 2'-8 x 5 GIRDERS = 80 FT²
(1152^k @ 100 psi)

SHEAR AREA (3): 9" x 7'8" → 50 FT²
(720^k @ 100 psi)

M(2): 36 KSI x 29.52 IN² x 69.17 = 73500^k'
18 KSI x 29.52 x 34.6 = 18385
27 KSI x 14.6 IN² x 51.8 = 20420
112000.^k'

M(3): (−) 4 - 1¼"□, STEEL-STEEL COUPLE, 5'-6" MOMENT ARM
4×1.23×36 ksi × 5.5' × 5 GIRDERS = 4871 k'

(+) 4871 + ~ 4½' × 20 × 1.23 × 36 × 5 = 24797 k'
19926

CHECK WORST OF LOAD CASES 1 & 2: (SPANS 7, 8, 9)

P = 203.5 ✓
$V_2$ = 735.2 < 1152×.85 = 979. ok
$V_3$ = 531.4 < 720×.85 = 612. ok
* { $M_2$ = 87060 (n=1) < 112000×.9 = 100,800 ok (PLUS CAN USE n=3)
$M_3$ = 5410 < 24797×.9 = 22317 ok (PLUS CAN USE n=3)

SPANS 7, 8 & 9 MEET CRITERIA.

n=3

* $\frac{87060 \div 3}{100\,800} + \frac{5410 \div 3}{22\,317} = 0.37$ ok
.29 .08

ANALYSIS RESULTS, EAST & WEST ABUTMENT WALLS

EAST ABUTMENT WALL (FIX TOP)

| | P | $V_2$ | $V_3$ | $M_2$ | $M_3$ | COMMENTS |
|---|---|---|---|---|---|---|
| STATIC ANALYSIS | | | | | | |
| BOTTOM | 2856 | 0 | 68.4 | 625.4 | 0 | STATIC 1.0 D.L. |
| TOP | 1297 | 0 | 68.4 | 3140. | 0 | |
| RESP. SPECTRUM | | | | | | |
| BOTTOM | 340. | 237. | 393. | 17007. | 7175. | 1.0 LE+.3TE |
| | 102. | 773. | 118. | 5102. | 23915. | 0.3LE+1.0TE |
| TOP | 273. | 126. | 347. | 3236. | 4.4 | 1.0 LE+.3TE |
| | 82. | 420. | 104. | 971. | 14.7 | .3LE+1.0TE |

WEST ABUTMENT WALL (PIN TOP 3-3)

| | P | $V_2$ | $V_3$ | $M_2$ | $M_3$ | |
|---|---|---|---|---|---|---|
| STATIC ANALYSIS | | | | | | |
| BOTTOM | 2974. | 0 | 39.2 | 4176. | 0 | |
| TOP | 1188. | 0 | 39.2 | 5825. | 0 | |
| RESPONSE SPECTRUM | | | | | | |
| BOTTOM | 428. | 208. | 353. | 17285. | 5988. | 1.0LE+.3TE |
| | 128. | 694. | 106. | 5156 | 19959. | .3LE+1.0TE |
| TOP | 321.4 | 72. | 284. | 3760. | 2. | 1.0LE+.3TE |
| | 96.4 | 241. | 85. | 1128. | 8. | .3LE+1.0TE |

COMBINED LOADS; USE 1.0 DL + EQK
CASE 1 = D + 1.0LE + .3TE
CASE 2 = D + .3LE + 1.0TE

EAST ABUTMENT WALL

| | P | $V_2$ (TRANS) | $V_3$ | $M_2$ | $M_3$ | |
|---|---|---|---|---|---|---|
| BOTTOM | 3196 (c) | 232. | 461.4 | 17632. | 7175 | D + 1.0LE + .3TE |
| | 2958 (c) | 773. | 186.4 | 5727. | 23915 | D + .3LE + 1.0TE |
| TOP | 1570. (c) | 126. | 415. | 6376. | 4.4 | D + 1.0LE + .3TE |
| | 1379. (c) | 420. | 172. | 4111. | 14.7 | D + .3LE + 1.0TE |

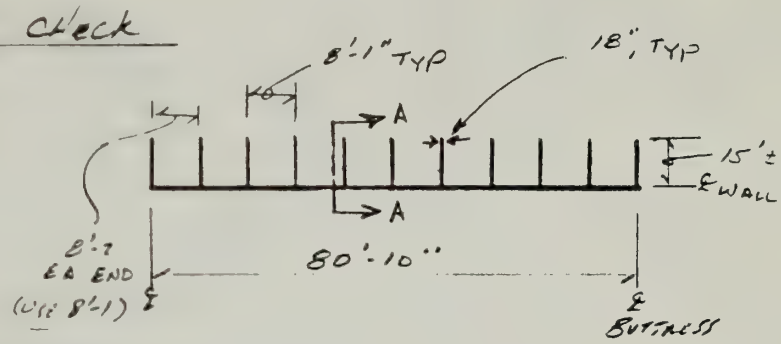
MIN COMP @ BASE = 2856 (D) − 340 (E) = 2516 K

WEST ABUTMENT WALL

| | P | $V_2$ (TRANS) | $V_3$ | $M_2$ | $M_3$ | |
|---|---|---|---|---|---|---|
| BOTTOM | 3412 | 208 | 392. | 21461. | 5988. | D + 1.0LE + .3TE |
| | 3102 | 694 | 145. | 9332. | 19959. | D + .3LE + 1.0TE |
| TOP | 1509. | 72. | 323. | 9585. | 2. | D + 1.0LE + .3TE |
| | 1284. | 241. | 124. | 6953. | 8. | D + .3LE + 1.0TE |

ABUTMENT WALLS - STRESS CHECK

DETERMINE ULTIMATE CAPACITIES @ BOTTOM:

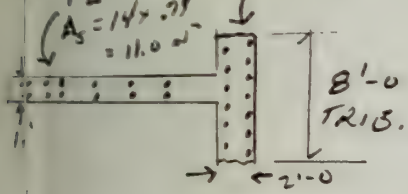



SECTION 1-1 (BOTTOM)

DETERMINE SECTION CAPACITY, WEAK AXIS OF ABUTMENT WALL ASSY.

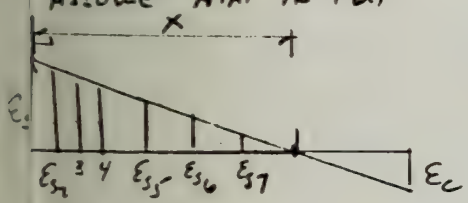
$I_T = 0.79\ in^2$

$1/2"\square$, $A_s = 16 \times \frac{1/2^2 \pi}{4} = 3.14\ in^2$




DUE TO ELEVATION OF FINISHED GRADE* BEHIND WALL, & AVAILABILITY OF PASSIVE EARTH PRESSURE TO RESIST MOTION INTO SLOPE, SECTION WILL BE CHECKED FOR MOMENTS PRODUCING MOTION AWAY FROM SLOPE ONLY.

ASSUME N.A. IN FLG




$\Sigma\ \varepsilon_{s_i} E_s A_{s_i} =$ COMP. (NEGLECTING AXIAL LOAD)

$\varepsilon_{s_1} = 0.00138 = \varepsilon_{sy}$ GR 40

$\varepsilon_1 = ((x-0)/x)\,\varepsilon_1$

$\varepsilon_2 = \varepsilon_1 (x-1)/x$

$\varepsilon_3 = \varepsilon_1 (x-2)/x$

$\varepsilon_4 = \varepsilon_1 (x-3)/x$

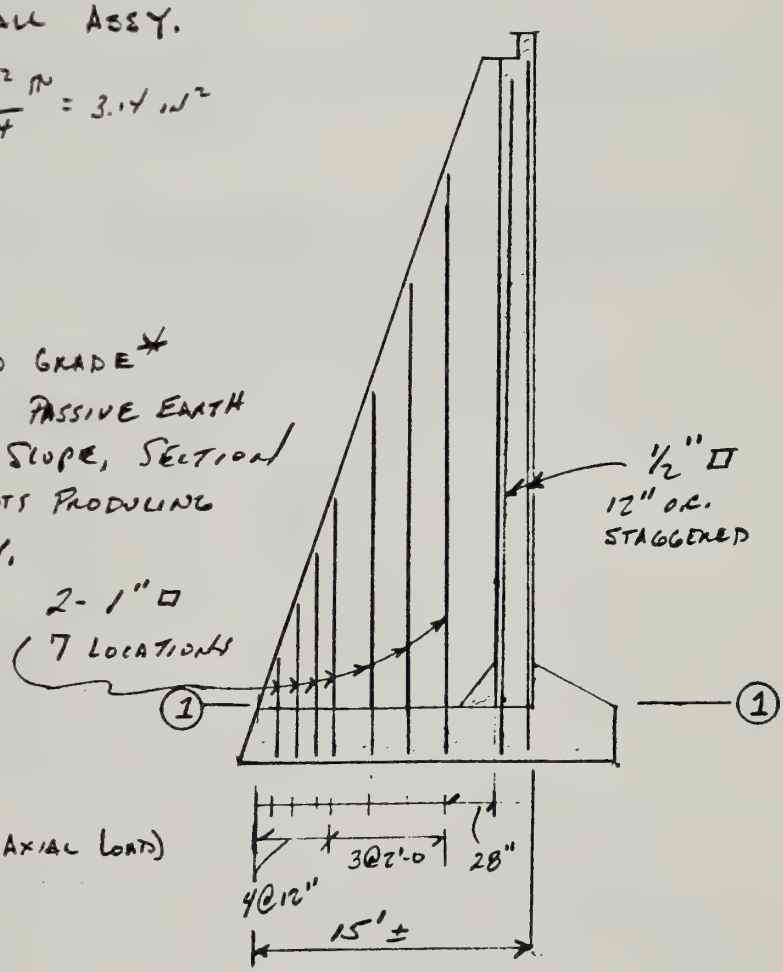
$\varepsilon_5 = \varepsilon_1 (x-5)/x$

$\varepsilon_6 = \varepsilon_1 (x-7)/x$

$\varepsilon_7 = \varepsilon_1 (x-9)/x$

ASSUMING $x > 9'$

→ SEE SKETCH ON FOLLOWING PAGE




SECTION A-A, TYP.

(REF DWG A673 DATED MAY 1910)

(ABUTMENT WALLS – CONT'D)

$T = \frac{\varepsilon_1}{x}\left((x-1)+(x-2)+(x-3)(x-5)+x-7+x-9\right) A_s E_s$

$T = (6x-27)\frac{\varepsilon_1}{x} A_s E_s$

$T = (.00138)(1.58)(29000)\frac{1}{x}(6x-27)$

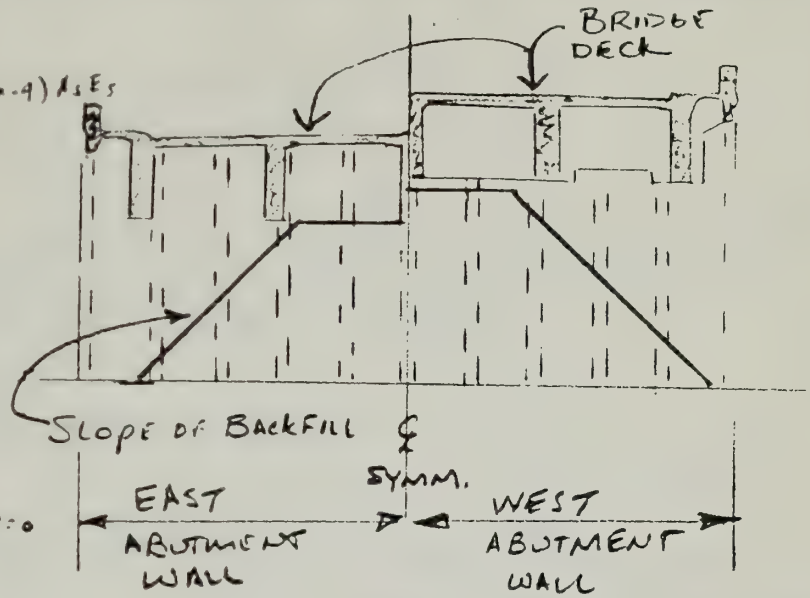
$C = .85(15-x)(\varepsilon')(.85 \times \frac{2500}{144})$

$C = .85^2\left(\frac{8(2500)}{144}\right)(15-x)$

$C = T \quad -100.34x^2 + 1505.1x + 1707 = 0$

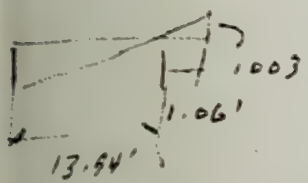
$x = 1.06'$

SLIGHT APPROX. W/ $\varepsilon_{STEEL}$. ACTUALLY MORE THAN COMP. STL YIELDS THIS LEVEL. ∴ MOMENT CAPACITY IS UNDER-ESTIMATED.

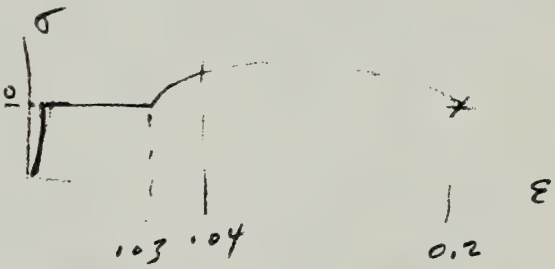



ELEVATION OF ABUTMENT WALLS
(SHOWING APPROX. SLOPE OF BACKFILL)
{REF DRWG A11322 DATED FEB 1936}

ACTUAL $\varepsilon_{S_1} = .003 \times \frac{13.94}{1.06} = 0.04$




Typ. σ-ε Gr 40 Steel




ε 3' FROM N/A = .003×3

∴ USE ALL STEEL IN STEM @ $f_y$

USE N.A. @ INSIDE FACE OF FLG

$2 - 1''\square \times 40$ KSI $= 2 \times 0.785\ IN^2 \times 40\ KSI = 62.8^K$

$28'' = 2.33'$

$M = 62.8^K(2.33' + 4.33 + 6.33 + 8.33 + 9.33 + 10.33 + 11.33)$
$+ 62.8^K \times 7 \times 1.15' = 3285^{K'} + 505.5^{K'} = 3791.^{K'}$

ASSUMED TENSILE VALUES

ASSUMED COMP. BLOCK

PER TYP "T"

CAPACITY OF ENTIRE SECTION $\simeq 11 \times 3791 = 41701.^{K'}$

(ABUTMENT WALLS — CONT'D)

MOMENT CAPACITY — STRONG AXIS OF ASSY:

$A_s$ EACH STEM @ BASE = 11.0 $in^2$

USE STEEL-STEEL COUPLET ONLY:

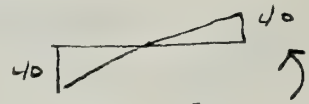
STEM: $11\ in^2 \times 20\ ksi \times (80.83' + 64.66 + 48.50 + 32.33 + 16.16) = 53,345.^{k'}$

{AVG σ, 0.7 f_y}

WALL: $15.7^{k}/_{1} \times \frac{40.4'}{2} \times 40.4' = 12\,812.^{k'}$

$0.393\ in^2/ft \times 40\ k/in^2 = 15.7^{k}/_{1}$

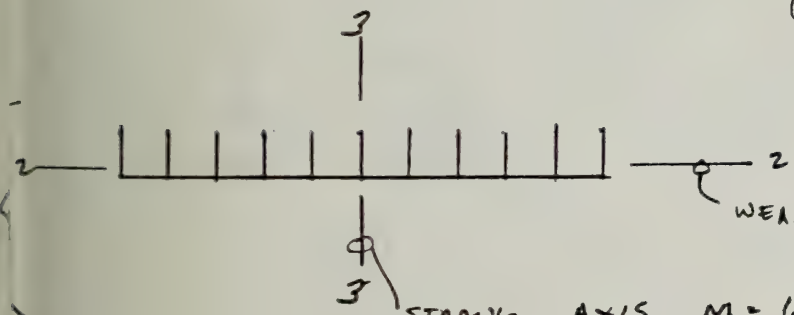
$\Sigma M_{CAPACITY} = 66,157.^{k'}$




(USING OUTER STEEL @ YIELD ONLY. — VERY CONSERVATIVE)

ACTUAL: $\varepsilon_c$; $\varepsilon_{TENSION}$

MOMENT CAPACITY MUCH HIGHER THAN 66,157.




WEAK AXIS $M_u = 41701.^{k'} \times .9 = \underline{37531.^{k'}}$

STRONG AXIS, $M_u = 66157.^{k'}$ (ACTUALLY MUCH LARGER)

DON'T USE $\phi = 0.9$ W/THIS CONSERV. EST. of m

@ BOTTOM

AXIAL AREA (COMPRESSION) $13' \times 1.5' \times 11 + 2' \times 82.5' = \underline{379.5\ ft^2}$

$P = 0.7 \times 379.5\ ft^2 \times 2500\ psi \rightarrow 95,634.^{k}$

SHEAR AREA: $A_{V_3} = 15' \times 1.5' \times 11 = 247.5\ ft^2$

$V_3 = 0.85 \times 247.5\ ft^2 \times 100\ psi \rightarrow 3029.^{k}$

SHEAR AREA: $A_{V_2} = 2' \times 82.5' = 165\ ft^2$

$V_2 = 0.85 \times 165\ ft^2 \times 100\ psi \rightarrow 2020.^{k}$

CHECK STRESS LEVELS : USE WINST OF CASES 1 & 2

EAST ABUTMENT : @ BOTTOM

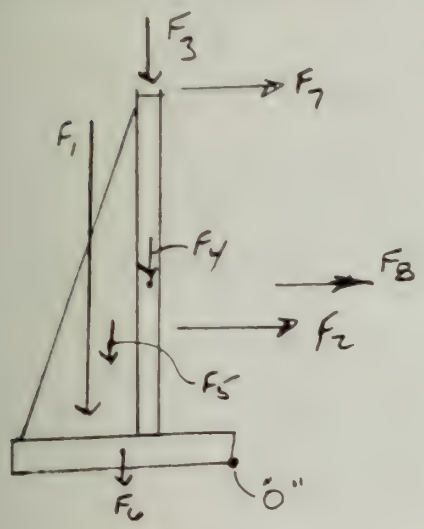
P = 3196.$^k$ (comp.) << 95634 (CAP. of CONC.) ok
$V_2$ = 773.$^k$ < 2020 ok
$V_3$ = 461.4$^k$ < 3029 ok
$M_2$ = 17632.$^{k'}$ (R=1) < 37531. 17632/37531 = 0.47
$M_3$ = 23915.$^{k'}$ (R=1) < 66157 23915/66157 = 0.36
0.83

W/R = 1.0 & CASE 1 + CASE 2 MOMENTS - ok

WEST ABUTMENT (@ BOTTOM)
P = 3402. << 95634 ok
$V_2$ = 694. < 2020 ok
$V_3$ = 392. < 3029 ok
$M_2$ = 21461. < 37531 21461/37531 = 0.57
$M_3$ = 19959. < 66157 19959/66157 = 0.30
0.87

W/R = 1.0
& NON CONCURRENT MOMENTS (CASE 1 & 2)
ok

STABILITY OF ABUTMENT WALLS TO RESIST OVERTURNING.
CHECK EAST ABUTMENT.




$F_1$ = SOIL DEAD LOAD
$F_2$ = SOIL PASSIVE PRESSURE
$F_3$ = D.L. RXN SUPER-STRUCTURE
$F_4$ = D.L. 2'-0 WALL
$F_5$ = D.L. STEM WALLS
$F_6$ = D.L. BASE
$F_7$ = EQK SHEAR @ TOP
$F_8$ = EQK, RETAINING WALL INERTIA LOAD

$d_i$ = MOMENT ARM TO "O" FOR RESPECTIVE FORCES.

$F_1$: DIRT BEHIND WALL APPROX 40' WIDE x 25' HIGH

$13' \times 40' \times 25' \times \frac{110}{1000}$ pcf $= 1430.^k = F_1$
$d_1 = 13'$

$F_2$: USE 30 pcf EQUIV. LIQUID
AREA COVERED = 40x25
USE $F_2 = \frac{(25')^2}{2} \times \frac{30 \text{ pcf}}{1000} \times 40' = 375.^k = F_2$
$d_2 = 11.33'$

$F_3$: $F_3 = \begin{cases} 3196^k \text{ (INCLUDING WT OF RETAINING WALL)} \\ -780 \end{cases}$ 780'k

$F_3 = 2416^k$ $d_3 = 5.5'$

$F_4$: $F_5$: $F_6$: TOTAL $F_4+F_5+F_6 = 780^k$, USE $d_{COMB_{4,5,6}} = 6.5'$

$F_7$: 415, $d_7 = 25.75'$
$F_8$: 461.4 − 415 = 46.4 $d_8$ = SAY 10'

$\Sigma M_{\circlearrowleft} = F_1 d_1 + F_3 d_3 + F_4 d_4 + F_5 d_5 + F_6 d_6 = 36948^{k'} > 15399$
$\Sigma M_{\circlearrowright} = F_2 d_2 + F_7 d_7 + F_8 d_8 = 15399$

NO OVTN PROBLEM. dc

EXPANSION JOINTS & BEARINGS:

TRANSVERSE SHEAR AT WEST ABUTMENT: (TOP) $V = 241^k$

BEARING AREA = 1'-6 x 1'-0 = 1½ FT²

$.7 \times .85 \times f'_c = 1487.5$ psi (2500)

USE of $\phi$ NOT NECESS. RQ'D - PER ATC-6-2

$216 \text{ in}^2 \times \frac{1487.5}{1000} = 321.^k$

x 2 SIDES = $642^k > 241^k$

ck $v_c$ @ INTERFACE - 1'-2" x 10' = 1680 in²

$v_c = A_v f_y / b_w S$ = .4x40/14"x12" = 95.2 in²

$v_{cas} = 195.2$ 1680+195.2 = $328^k > 321$ ← (NO $\phi$)

TRANSVERSE SHEAR AT EAST & WEST END RETAINING WALLS:

16" x 16" LOAD & BEARING.
EFFECTIVE BEARING AREA = 13" x 16" = 208 in².
2 BEARINGS EFFECTIVE EA. DIRECTION @ EA. END.

0.85 x 0.7 x 2500 = 1487 psi
x 208 in² = $309.4^k$ EA

TOTAL LATERAL CAPACITY* = $618.8^k$ (@ EA "RETAINING" WALL).

APPLIED LOAD, 10 TO 80' SPECTRA = $1553^k$ (EAST END)
& $1444.^k$ (WEST END)

ACTUAL SPECTRA RQ'D IS 0 TO 10'
LOADS = $1037^k$ (EAST END)
$1116^k$ (WEST END)

REF SSB SETSAB18.OUT
10-12-84

* BASED ON BEARING; PROBABLY NOT CAPABLE of DEVELOPING THIS LOAD THROUGH BM LOADED @ BOTTOM EDGE.

EXPANSION JOINTS & BEARINGS (CONT'D)

$618.8^k < \frac{1116.}{.8} = 1395^k$ ∴ LATERAL RESTRAINT @ THIS LOCATION IS NOT ADEQUATE.

"R"

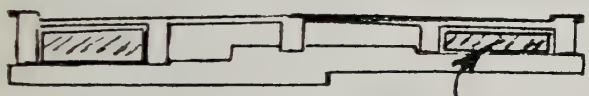
ACCORDING TO DRAWING A-11326 (FEB 1936) SECT. A-A, FOOTING IS TO BE EMBEDED INTO SOLID ROCK @ BOTH SIDES AT LEAST 1'-6" - ASSUME ROCK ULT COMP = 1200 PSI

$1.5' \times 4' \times 144 \times \frac{1200}{1000} = 1037^k$

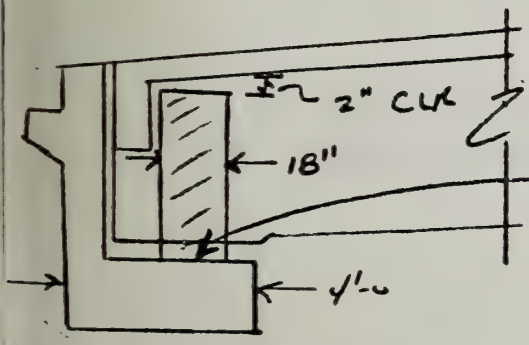
FRICTION, $\mu = 1.0$ 250k
D.L. RXN ~250k 1287k

ABUTMENT IS MARGINALLY CAPABLE of TRANSMITTING SHEAR. SAY OK, (1'-6" IS THE MINIMUM EMBED.)

RECOMMENDATION*: ADD SHEAR PANEL CAPABLE of TRANSMITTING ADDITIONAL 800k (400k EA SIDE)



NEW PANEL EA SIDE, NEOPRENE PADS @ EA SIDE (or TEFLON PADS) DOWEL INTO ABUTMENT FROM BOTTOM.




~60 DOWELS REQ'D TO BE DRILLED IN & EPOXIED (1" ϕ) @ INTERFACE + PERIMETER STEEL

* SEE ALTERNATE NEXT PAGE

NO ALTERNATE RECOMMENDATION IS PREFERRED

ALTERNATE TO NEW PANELS INSTALLED @ ABUTMENTS:

USE 0 to 10' SPECTRAL RESULTS, & USE FULL ALLOWABLE DUCTILITY, DISTRIBUTE EXCESS INTO INTERIOR WALLS.

$V_{TOP} = 172.^k$ (FROM .3 LONG + 1.0 TRANS)
@ BENT 3

CAPACITY OF CONNECTION @ TOP OF WALL TO SUPERSTRUCT.
@ BENT 3, USE $0.85 \times f'_c \times A = 0.85 \times 2500 \times 216 \times 2 \times 1/1000 = 918^k$
EXCESS CAPACITY OF THIS CONNECTION $= 918 - \frac{172}{.8} = 703^k$
( "R" = 0.8

APPLIED LOAD @ ABUTMENT 4 = $1116^k$ (WEST ABUTMENT)
REDISTRIBUTE LOAD FROM ABUTMENT 4 INTO WALL @ 3

EXCESS DEMAND $= \frac{1116}{.8} - 703 = 692^k$

TAKE SHEAR INTO END REGIONS - $4.7' \times 2'\text{-}0 \times 144 = 1353\ in^2$
#12@16, $v_s = 0.4 \times 40/14 \times 16 = 42psi$ $1353 \times 142 = 192.^k$
D.L. = $1188^k$ (REF. STBSTATIC1.OUT)
MAX R.S. = $227^k$ (REF STBSEISAB1B.OUT)
$961^k$ MIN COMPRESSION
BRASS-BRASS, STATIC COEFF OF FRICTION ≈ 0.5

$961 \times 0.5 = 480^k$ — 0.5 REASONABLE
$+ 192$ CONSIDERING R=0.8 USED.
$672^k$ ≈ CLOSE 692

ok.

ABUTMENT WALL; R=2.0 IS ACCEPTABLE.
WALL OK BY INSPECTION.

over Alemany

Bryant Street
between 2nd & Beale

SUPPORTING CALCULATIONS:

EVALUATION OF SEISMIC ADEQUACY

BRYANT ST. VIADUCT BETWEEN 2ND & BEALE

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URS/BLUME

130 Jessie Street (at New Montgomery)
San Francisco, California 94105

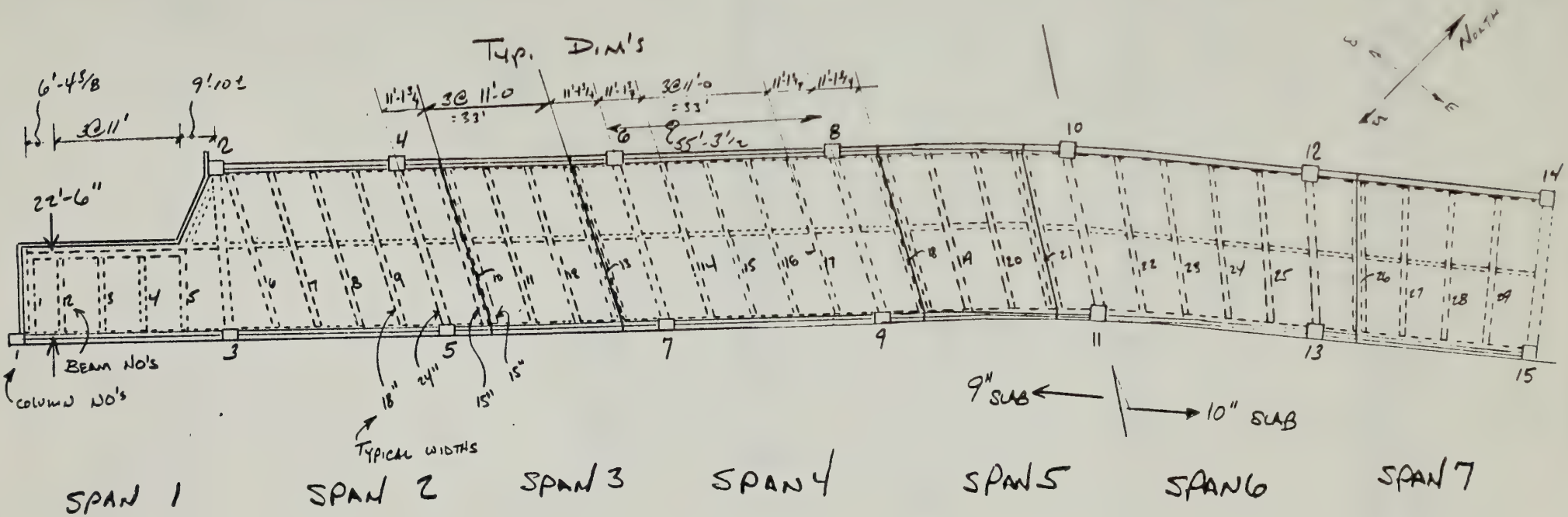
JOB NO. 8478 JOB

CLIENT SUBJECT BRYANT ST. VIADUCT BETWEEN 2ND & BEALE

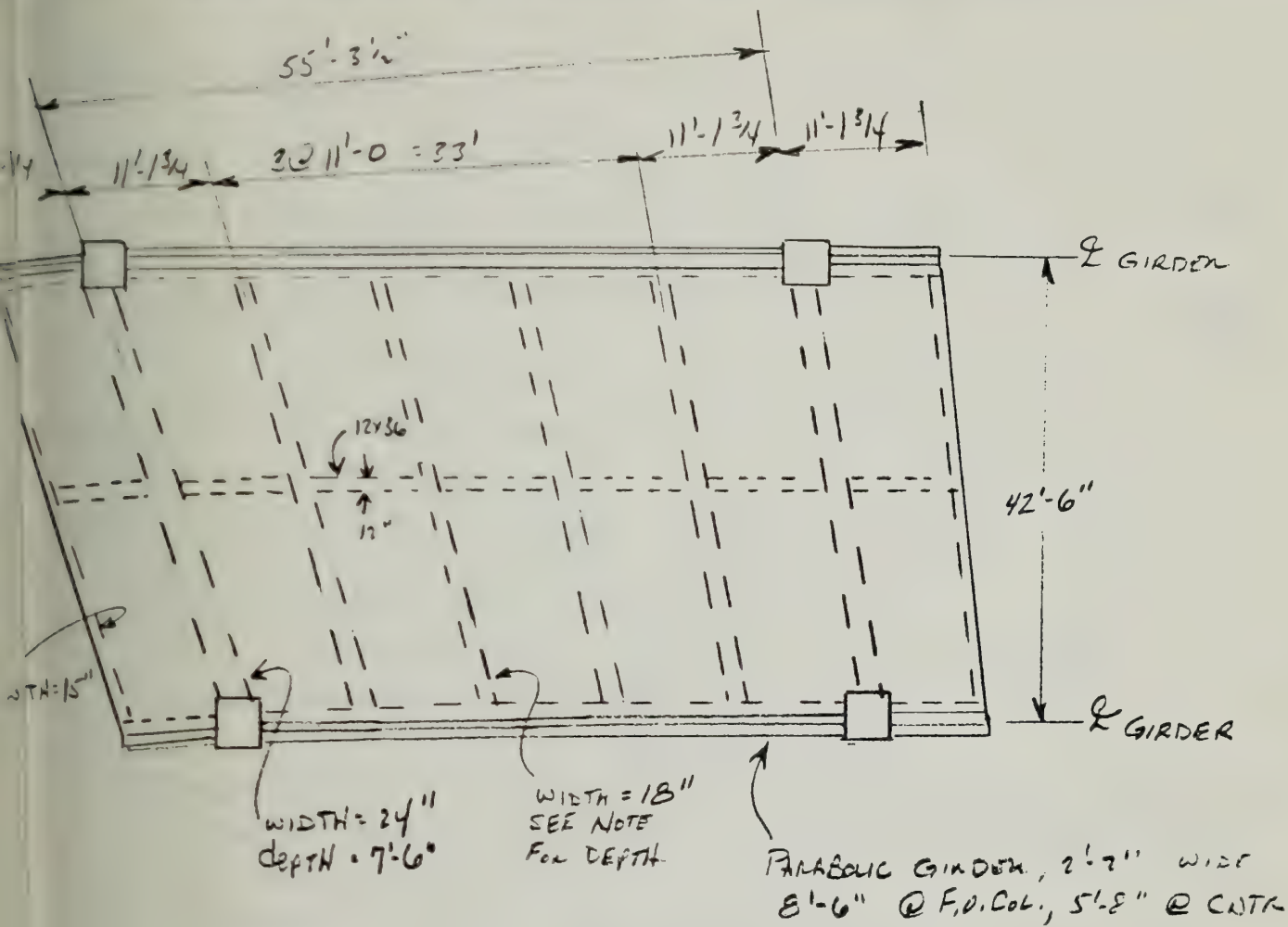
SHEET NO.

BY EJB DATE 6-19-84

CHK'D DATE




REF B-19703 B-19708
B-19704
B-19706




TYPICAL SPAN

NOTE-

DEPTH = 4'-0 FOR BEAM NO'S 1 TO 17 INCLUSIVE
= 4'-3" " " " 18 TO 21 INCLUSIVE
= 4'-6" " " " 22 TO 29 INCLUSIVE

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 3

D 8/23 JOB BY EJB DATE 6-19-74

SUBJECT BRYANT ST. VIADUCT BETWEEN 2ND & BEALE CHK'D DATE

DEAD LOAD OF DECK

BALSTRADE - TYP PER SPAN

CONC. @ ENDS - 4'-0 × 3'-0 × 4'-4 × 0.15 = 7.8^k

RAIL - ~ (29" × 10" × 3'-10") - (11" × 29½") + 11 × 8½ × 29" → 15727.1 in³

29" + MODULE 9.1 FT³ × 21 MODULES × 0.15 = 28.7^k

36.5^k

SPAN 1 9" SLAB, BEAMS 4'-0 deep, 18" WIDE

BEAMS 1, 2, 3, 4, 5 SPAN ℄ GIRDER ℄ GIRDER = 22'-6"

LENGTH = 22'-6" - (1'-6/2) - (2'-2/2) = 20.67'

DEPTH LESS SLAB = 4'-0 - (9") = 3.25'

1.5' × 20.67' × 3.25 × 5 BEAMS × 0.15 = 75.6^k

STRAIGHT GIRDER: 5.5' × 1.5' × (33 + 6.36 + 24.55 + 8') × 0.15 = 89.^k

STRAIGHT < PARTIAL STRAIGHT

PARABOLIC GIRDER: (2'-2" × 55'-3½ × 8'-6 - 2/3 (55'-3½)(2.83')) × 2'-2) × 0.15 = 119^k

SLAB (20.67' × (6.36 + 33 + 9.83) + 9.83 × 22.5' × ½) × 9/12 × 0.15 = 127^k

½ GIRDER COL 2 - COL 3 ((42'-6" - (2')) × 2'/2 × (7'-6" - (9")) × 0.15 = 41.^k

BALSTRADE - 1 SIDE ONLY (SEE ABOVE) 36.5

SIDEWALK CURB/SLAB 8' × 6" × 55'-3½" × 0.15 33.

521^k

SPAN 2

(DEPTH LESS SLAB = 3.50', SPAN = (42'-6) - (2'-2") = 40'-4" = 40.33 FT

BEAMS 6, 7, 8, 9: 1.5' × 3.25' × 40.33' × 4 BEAMS × 0.15 = 118^k

½ GIRDER 2-3 & 4-5 2 × 41^k = 82^k

GIRDER ALONG ℄; 12" × 36" × (55'-3½" - (18" × 4 + 2')) × 0.15 = 21^k (47.27')

SLAB (55'-3½) × (42'-6" + 2'-2") × 9" × 0.15 = 278^k

BALSTRADE - 2 SIDES 36.5^k × 2 73^k

PARABOLIC GIRDER: 2 SIDES × 119^k 238

SIDEWALK CURB/SLAB 13.5' × 6" × 55'-3½" × 0.15 56^k

866.^k

SPAN 3

CANTILEVER PORTION - EA SIDE
USE % FROM SPAN 2 (APPROX)

$(866 - 82^k) \times \frac{11'-1\frac{3}{4}}{55'-3\frac{1}{2}} + 41^k = \underline{199^k}$

CENTER SPAN BETWEEN CANTILEVERS -

$866 - 2 \times 199 = \underline{468^k}$

SPAN 4

SAME AS SPAN 2 $= \underline{866^k}$

SPAN 5

SAME AS SPAN 3 BUT TRANSVERSE GIRDERS ARE 4'-3" deep (VS/4'-0)

CANTILEVER - $199^k + (1.5' \times 3'' \times 40.33' \times 1 \text{ BEAM}) \times 0.15 = \underline{202^k}$

CENTER SPAN - $468^k + (1.5' \times 3'' \times 40.33' \times 4 \text{ BEAMS}) \times 0.15 = \underline{477^k}$

SPAN 6

SAME AS SPAN 2 BUT TRANSVERSE GIRDERS ARE 4'-6" deep (VS 4'-0) + SLAB IS 10" (VS 9")

$866^k + (1.5 \times 6'' \times 40.33' \times 4 \text{ BEAMS}) \times 0.15$
$+ (55'-3\frac{1}{2}'') \times (44'-8'') \times 1'' \times 0.15 = 915^k$

SPAN 7

CANTILEVER: $(915^k - 82^k) \frac{11'-1\frac{3}{4}}{55'-3\frac{1}{2}} + 41^k = 209^k$

REMAINDER: $915^k - 209^k = 706^k$

S/BLUME
Jesse Street (at New Montgomery)
Fancisco, California 94105

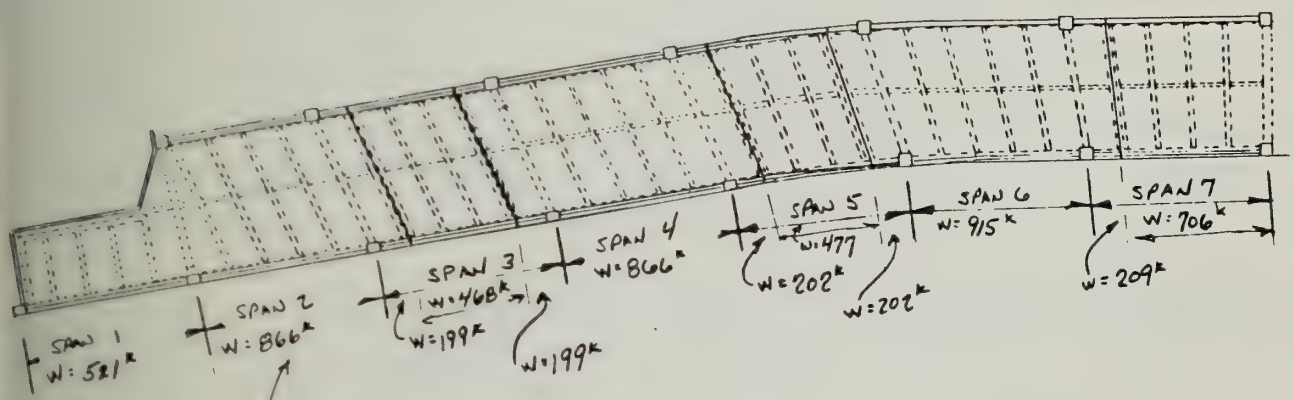
SHEET NO. 5

D 8438 JOB BY EMB DATE 6-84

SUBJECT BRYANT ST MARKET BETWEEN 2ND & SEVILLE CHK'D DATE

SUMMARY OF DECK DEAD-LOADS

NOTE - DOES NOT INCLUDE A.C. ON TOP OF R/C STRUCT.



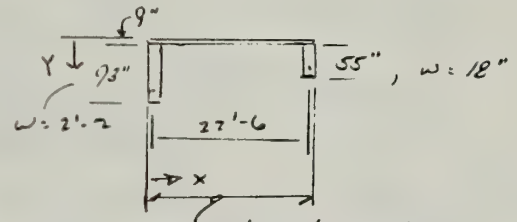

A.C. : 0.53 k/'
SPAN 1 only

A.C. : 1.06 k/'
Typ.

ELASTIC PROPERTIES of BRIDGE DECK - SPAN 1

℄ GIRDER — ℄ GIRDER = 22'-6"
EAST GIRDER - PARABOLIC — SAME GEOMETRY AS OTHER SPANS
WEST GIRDER - RECTANGULAR 5'-4" ± DEPTH
USE SECTION PROPERTIES for I SECTIONS, PARABOLIC GIRDER d: 93, 70.5, 59"

SECTION 1, d = 93" (+9" SLAB)




2418 990 2628

$A = 93\times26 + 55\times18 + 292\times9 = \underline{6036}\ in^2$

$\bar{x} = \frac{1}{6036}(2418\times13 + 990\times283 + 2628\times146) = 115.2"$

$\bar{Y} = \frac{1}{6036}(2418\times55.5 + 990\times36.5 + 2628\times4.5) = 30.2"$

$I_{22} = 26\times93^3\times1/12 + 2418\times25.3^2 + 18\times55^3\times1/12 + 990\times6.3^2 + 292\times9^3\times1/12 + 2628\times25.7^2$
(HORIZ AXIS) $\underline{I_{22} = 5.3329\times10^6\ in^4}$ (257.2 $FT^4$)

$I_{11} = 93\times26^3\times1/12 + 2418\times102.2^2 + 55\times18^3\times1/12 + 990\times167.8^2 + 9\times292^3\times1/12 + 2628\times30.8^2$
(VERT AXIS) $\underline{I_{11} = 74.46\times10^6\ in^4}$ (3591. $FT^4$)

SECTION 2, d = 70.5

1833

$A = 70.5\times26 + 990 + 2628 = \underline{5451.\ in^2}$

$\bar{x} = \frac{1}{5451}(1833\times13 + 990\times283 + 2628\times146) = 126.16"$

$\bar{Y} = \frac{1}{5451}(1833\times44.25 + 990\times36.5 + 2628\times4.5) = 26.68"$

$I_{11} = 70.5\times26^3\times1/12 + 1833\times113.16^2 + 55\times18^3\times1/12 + 990\times156.84^2 + 9\times292^3\times1/12 + 2628\times19.84^2$
(VERT AXIS) $\underline{I_{11} = 67.662\times10^6\ in^4}$ (3263. $FT^4$)

$I_{22} = 26\times70.5^3\times1/12 + 1833\times17.57^2 + 18\times55^3\times1/12 + 990\times9.82^2 + 292\times9^3\times1/12 + 2628\times22.16^2$
(HORIZ AXIS) $\underline{I_{22} = 2.9807\times10^6\ in^4}$ (143.7 $FT^4$)

SECTION 3 d = 59"

1534

$A = 59\times26 + 990 + 2628 = \underline{5152.\ in^2}$

$\bar{x} = \frac{1}{5152}(1534\times13 + 990\times283 + 2628\times146) = 132.73"$

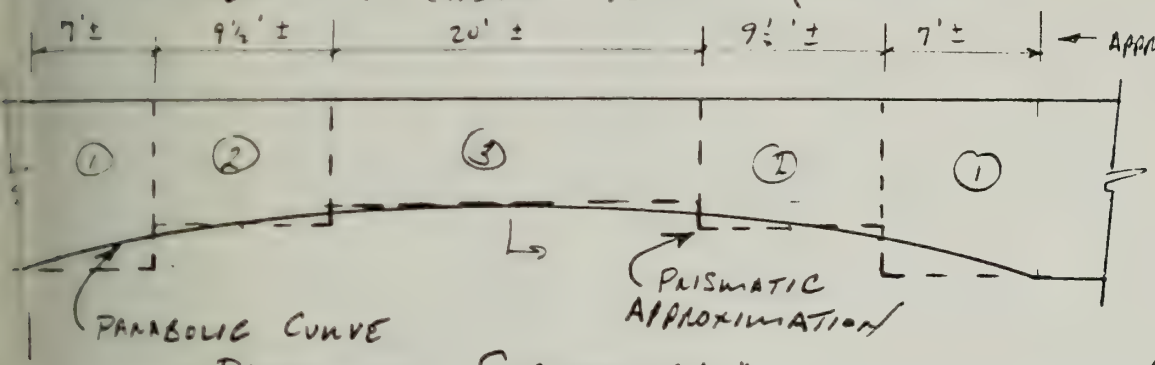
$\bar{Y} = \frac{1}{5152}(1534\times38.5 + 990\times36.5 + 2628\times4.5) = 20.77"$

$I_{11} = 59\times26^3\times1/12 + 1534\times119.73^2 + 55\times18^3\times1/12 + 990\times150.77^2 + 9\times292^3\times1/12 + 2628\times13.77^2$
(VERT AXIS) $\underline{I_{11} = 63.743\times10^6\ in^4}$ (3074. $FT^4$)

$I_{22} = 26\times59^3\times1/12 + 1534\times17.73^2 + 18\times55^3\times1/12 + 990\times15.73^2 + 292\times9^3\times1/12 + 2628\times16.27^2$
$\underline{I_{22} = 2.1351\times10^6\ in^4}$ (103.0 $FT^4$)

ELASTIC PROPERTIES OF BRIDGE DECK: TYPICAL SPAN (2,3,4,5)
(9" SLAB)

℄ GIRDER TO ℄ GIRDER = 42'-6" (510")




PARABOLIC GIRDER (2'-2" WIDE)
SCALE, 3/32" = 1'-0

| SECTION | TOTAL DEPTH* |
|---|---|
| 1 | 8'-6" |
| 2 | 6'-7½" |
| 3 | 5'-8" |

* INCLUDES SLAB

℄ PARABOLIC CURVE -

| LOCATION | DISPL | | |
|---|---|---|---|
| 0' | 0 | ← SECTION 1 | 93" (FROM BOTT of SLAB) |
| 5' | 0.11' | | |
| 10' | 0.43' | | |
| 15' | 0.97' | ← SECTION 2 | 70.5" |
| 20' | 1.72' | | |
| 25' | 2.69' | | |
| 25.65' | 2.83' | ← SECTION 3 | 59" |

SECTION 1: (67.08 FT²)
9" SLAB

A: $9'' \times (510'' + 26'') + 93'' \times 26'' \times 2 = \underline{9660 \text{ in}^2}$
(4824) (2418 × 2)

$I_{11}$ : $9 \times (536)^3 \times 1/12 + 2(93 \times 26^3 \times 1/12 + 2481 \times 255^2)$
(VERT AXIS)

$\underline{I_{11} = 438.42 \times 10^6 \text{ in}^4}$ (21143. FT⁴)

$\bar{Y} = \frac{1}{9960}\left(4824 \times 4\tfrac{1}{2} + 2418 \times 2 \times \left(\tfrac{93}{2} + 9\right)\right) = 29.13''$

$I_{22}$ : SLAB d: 24.63" GIRDERS d: 26.37"
(HORIZ AXIS) $I_{22} = 536 \times 9^3 \times 1/12 + 4824 \times 24.63^2 + 2 \times 26 \times 93^3 \times 1/12 + 4836 \times 26.37^2$

$\underline{I_{22} = 9.5572 \times 10^6 \text{ in}^4}$ (460.9 FT⁴)

ELASTIC PROPERTIES of BRIDGE DECK, CONT'D

SECTION 2 : $A = 4824 + \overset{1833\times 2}{70.5 \times 26 \times 2} = \underline{8490}\ in^2$ $(58.96\ ft^2)$

9" SLAB

$I_{11}$ : $\overset{115.49\times 10^6}{9\times 536^3 \times 1/12} + 2(70.5\times 26^3 \times 1/12 + 1833 \times 255^2) = \underline{354.08\times 10^6\ in^4}$

(VERT AXIS) $(17075\ ft^4)$

$\bar{Y} = \frac{1}{8490}\left(4824 \times 4\tfrac{1}{2} + 1833 \times 2 \times \left(\tfrac{70.5}{2} + 9\right)\right) = 21.66''$

$I_{22}$ : SLAB, $d = 17.16''$ GIRDERS, $d = 22.59''$

(HORIZ AXIS)

$I_{22} = \overset{32562}{536 \times 9^3 \times 1/12} + 4824 \times 17.16^2 + 2 \times 26 \times 70.5^3 \times 1/12 + 1833 \times 2 \times 22.59^2$

$\underline{I_{22} = 4.8423 \times 10^6\ in^4}$ $(233.52\ ft^4)$

SECTION 3

9" SLAB $A = 4824 + \overset{1534\times 2}{59 \times 26 \times 2} = 7892.\ in^2$

$I_{11}$ : $115.49\times 10^6 + 2(59 \times 26^3 \times 1/12 + 1534 \times 255^2) = \underline{315.16 \times 10^6\ in^4}$

(VERT. AXIS) $(15199.\ ft^4)$

$\bar{Y} = \frac{1}{7892}\left(4824 \times 4\tfrac{1}{2} + 1534 \times 2 \times \left(\tfrac{59}{2} + 9\right)\right) = 17.72''$

$I_{22}$ : SLAB, $d = 13.22''$ GIRDERS, $d = 20.78''$

(HORIZ AXIS)

$I_{22} = 32562. + 4824 \times 13.22^2 + 2 \times 26 \times 59^3 \times 1/12 + 2 \times 1534 \times 20.78^2 = \underline{3.0904 \times 10^6\ in^4}$

$(149.04\ ft^4)$

S/BLUME
essie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 9

NO. 5438 JOB BY SJB DATE 7-84

T SUBJECT BAYANT ST. VIADUCT BETWEEN 2ND & BEALE CHK'D DATE

ELASTIC PROPERTIES OF BRIDGE DECK - SPANS 6 & 7

(SAME AS SPANS 2, 3, 4, 5 BUT W/ 10" SLAB)

SECTION Q 10" SLAB, 92" GIRDER DEPTH (FROM BOTT of SLAB)

10" SLAB $A = 10 \times 536 + 92 \times 26 \times 2 = 10144.$ IN²

$I_{11} = 10 \times 536^3 \times 1/12 + 92 \times 26^3 \times 1/12 \times 2 + 92 \times 26 \times 2 \times 255^2 = 439.67 \times 10^6$ IN⁴

(VERT AXIS) $128.33 \times 10^6$ $269.5 \times 10^3$ $311.08 \times 10^6$

(21203. FT⁴)

VS/21143. W/9" SLAB

DIFFERENCE NOT SIGNIFICANT. (0.3%)

$\bar{Y} = \frac{1}{10144.}(5360 \times 5 + 92 \times 26 \times 2 \times 56) = 29.05"$

$I_{22}$ : SLAB d = 24.05" GIRDERS, d = 26.95"

$I_{22} = 536 \times 10^3 \times 1/12 + 5360 \times 24.05^2 + 92^3 \times 26 \times 2 \times 1/12 + 92 \times 26 \times 2 \times 26.95^2 =$

$I_{22} = 10.0 \times 10^6$ IN⁴ = 482. FT⁴

VS/461. FT⁴ W/9" SLAB → 4½%

DIFFERENCE ≈ NOT SIGNIFICANT.

USE SECTION PROPERTIES FROM 9" SLAB (SPANS 2, 3, 4, 5) FOR SPANS 6 & 7 ALSO.

/BLUME
ssie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 10

JOB

BY SOB DATE 10-84

SUBJECT BRYANT BETWEEN 2ND & BEALE

CHK'D DATE

STATIC ANALYSIS RESULTS* / COLUMNS

| ENT | COLUMN | | LONGIT. MOMENT | LONGIT. SHEAR | TRANS. MOMENT | TRANS. SHEAR | AXIAL |
|---|---|---|---|---|---|---|---|
| 2 | 1 | Bottom | 0 | +64.3 | 0. | +6.4 | +434. |
| | | Top | +1679.5 | -64.3 | -167.1 | -6.4 | -371.4 |
| | 2 | B | 0 | -64.3 | 0 | +6.4 | 434. |
| | | T | -1679.5 | +64.3 | -167.1 | -6.4 | -371.4 |
| 3 | 1 | B | 0 | +99.5 | 0 | -19.8 | +536.9 |
| | | T | 2318.1 | -99.5 | +460.3 | +19.8 | -481. |
| | 2 | B | 0 | -99.5 | 0 | -19.8 | +536.9 |
| | | T | -2318.1 | +99.5 | +460.3 | +19.8 | -481. |
| 4 | 1 | B | 0 | +118.5 | 0 | +16.6 | +499.8 |
| | | T | 2417.7 | - ↕ | -339.6 | - ↕ | -457.5 |
| | 2 | B | 0 | - ↓ | 0 | - ↓ | +499.8 |
| | | T | -2417.7 | +118.5 | -339.6 | +16.6 | -457.5 |
| 5 | 1 | B | 0 | +144.6 | 0 | -2.1 | 499.8 |
| | | T | 2545.4 | - ↕ | +37.3 | + ↕ | -457.5 |
| | 2 | B | 0 | - ↓ | 0 | - ↓ | 499.8 |
| | | T | 2545.4 | +144.6 | +37.3 | +2.1 | -457.5 |
| 6 | 1 | B | 0 | +188.8 | 0 | +3.5 | +495.1 |
| | | T | +2775.7 | - ↕ | -50.8 | - ↕ | -459.8 |
| | 2 | B | 0 | - ↓ | 0 | + ↓ | +495.1 |
| | | T | -2775.7 | +188.8 | -50.8 | -3.5 | -459.8 |
| 7 | 1 | B | 0 | 305.5 | 0 | -20.9 | +581.3 |
| | | T | +3635.7 | ↕ | +249. | + ↕ | -552.7 |
| | 2 | B | 0 | ↓ | 0 | - ↓ | +581.3 |
| | | T | -3635.7 | 305.5 | +249. | +20.9 | -552.7 |

* REF STBSTATIC4B.OUT
(w/o HINGE @ 7)

THESE 2 columns contain FICTITIOUS STATIC RESULTS, SEE CALCS

FS/BLUME
essie Street (at New Montgomery)
n Francisco, California 94105

0' TO 10' 0 SPECTRA

SHEET NO. 11

JOB

BY EOR DATE 1/1-5-W

SUBJECT BRYANT BETWEEN 2ND & BEALE

CHK'D DATE

RESPONSE SPECTRUM ANALYSIS RESULTS* / COLUMNS

| ENT | CASE / LOCATION | LONGITUDINAL MOMENT | LONGITUDINAL SHEAR | TRANSVERSE MOMENT | TRANSVERSE SHEAR | AXIAL |
|---|---|---|---|---|---|---|
| 2 | 1 Bottom | 0 | 107 | 0 | 466 | |
| | Top | 2712 | 101 | 11864. | 441 | 344 |
| | 2 B | 0 | 208. | 0 | 240 | 305 |
| | T | 5241 | 192 | 6094. | 226 | |
| 3 | 1 B | 0 | 252. | 0 | 528. | 563 |
| | T | 5762. | 242. | 12073 | 507 | |
| | 2 B | 0 | 601 | 0 | 295 | 724 |
| | T | 13667. | 570. | 6732. | 282 | |
| 4 | 1 B | 0 | 260 | 0 | 415 | 562 |
| | T | 5204 | 244 | 8197. | 306 | |
| | 2 B | 0 | 545 | 0 | 386 | 612 |
| | T | 10842. | 515 | 6043. | 284 | |
| 5 | 1 B | 0 | 271. | 0 | 564 | 493 |
| | T | 4715. | 264 | 9732. | 540 | |
| | 2 B | 0 | 551. | 0 | 444 | 530 |
| | T | 9531. | 530. | 7661 | 425 | |
| 6 | 1 B | 0 | 387. | 0 | 705. | 695. |
| | T | 5645. | 380. | 10238. | 686. | |
| | 2 B | 0 | 546. | 0 | 328. | 505 |
| | T | 7891. | 526. | 4755. | 318. | |
| 7 | 1 B | 0 | 523 | 0 | 705. | 695. |
| | T | 6199. | 514 | 10238. | 686. | |
| | 2 B | 0 | 663 | 0 | 328. | 505. |
| | T | 7826. | 651 | 4755 | 318. | |

* REF STBSEKSAB4B.OUT

CASE 1 = 1.0 LONGIT + 0.3 TRANS
2 = 0.3 LONGIT + 1.0 TRANS

S/BLUME
ssie Street (at New Montgomery)
francisco, California 94105

0' TO 10' SPECTRA NO HINGES

SHEET NO. 12

JOB

BY BDB DATE 1-84

SUBJECT BRYANT BETWEEN 2ND & BEALE

CHK'D DATE

STATIC x 1.0 + RESPONSE SPECTRUM x 1.0 RESULTS / COLUMNS

| EXT | LOAD CASE / LOCATION | LONGITUDINAL MOMENT | LONGITUDINAL SHEAR | TRANSVERSE MOMENT | TRANSVERSE SHEAR | AXIAL |
|---|---|---|---|---|---|---|
| | 1 Bottom | 0 | 171 | 0 | 472 | 27. C |
| 2 | Top | 4392 | 165 | 12031 | 447 | 778 C |
| | 2 B | 0 | 272. | 0 | 246 | 66 C |
| | T | 6921 | 256 | 6261 | 232 | 676 C |
| | 1 B | 0 | 352 | 0 | 548. | 82. T |
| 3 | T | 8080. | 342. | 12533 | 527 | 1100. C |
| | 2 B | 0 | 701. | 0 | 315. | 243. T |
| | T | 15985. | 670. | 7192. | 302. | 1261. C |
| | 1 B | 0 | 379. | 0 | 432. | 104. T |
| 1 | T | 7622. | 368. | 8537 | 323. | 1062. C |
| | 2 B | 0 | 664. | 0 | 403 | 154. T |
| | T | 13260. | 634. | 6383. | 301 | 1112. C |
| | 1 B | 0 | 416. | 0 | 566. | 35. T |
| 5 | T | 7260. | 409. | 9769. | 542. | 993. C |
| | 2 B | 0 | 696. | 0 | 446. | 72. T |
| | T | 12076. | 675. | 7698. | 427. | 1030. C |
| | 1 B | 0 | 576. | 0 | 709. | 235. T |
| | T | 8421. | 569. | 10288. | 690. | 1190. C |
| | 2 B | 0 | 735. | 0 | 332. | 45. T |
| | T | 10667. | 715. | 4806. | 322. | 1000. C |
| | 1 B | 0 | 829 | 0 | 726. | 142. T |
| 1 | T | 9835 | 825 | 10487. | 707. | 1276. C |
| | 2 B | 0 | 969 | 0 | 349. | 48. C |
| | T | 11462. | 957 | 5004. | 339. | 1086. C |

G + E
+ E

REF: STBSEISAB48.OUT
+ STBSTATIC48.OUT
THESE TWO COL'S CONTAIN FICTITIOUS STATIC ANALYSIS RESULTS, SEE CALCS.

CASE 1 = 1.0 LONGIT + 0.3 TRANS
2 = 0.3 LONGIT + 1.0 TRANS

S/BLUME
essie Street (at New Montgomery)
Francisco, California 94105

0 TO 10' SPECTRA W/HINGE @ 7

SHEET NO. 13
NO. 8438 JOB
BY SMB DATE 11-84
SUBJECT BRYANT ST. BETWEEN 2ND & BEALE CHK'D DATE

STATIC ANALYSIS RESULTS *

| BENT | | LONGITUDINAL MOMENT | LONGITUDINAL SHEAR | TRANSVERSE MOMENT | TRANSVERSE SHEAR | AXIAL |
|---|---|---|---|---|---|---|
| 2 | BOTTOM | 0 | 64.3 | 0 | 6.4 | 434 |
| | TOP | 1679 | 64.3 | 167. | 6.4 | 371 |
| | B | | | | | |
| | T | " | " | " | " | " |
| 3 | B | 0 | 100 | 0 | 20 | 537 |
| | T | 2318. | 100 | 460. | 20 | 481 |
| | B | | | | | |
| | T | " | | | | |
| 4 | B | 0 | 119 | 0 | 17 | 517 |
| | T | 2418. | 119 | 340 | 17 | 468. |
| | B | | | | | |
| | T | " | | | | |
| 5 | B | 0 | 145. | 0 | 2 | 500 |
| | T | 2545 | 145. | 37. | 2 | 458. |
| | B | | | | | |
| | T | " | | | | |
| 6 | B | 0 | 189. | 0 | 18 | 495 |
| | T | 2776. | 189. | 257 | 18 | 460 |
| | B | | | | | |
| | T | " | | | | |
| 7 | B | 0 | 306 | 0 | 0 | 581 |
| | T | 3636. | 306 | 0 | 0 | 553 |
| | B | | | | | |
| | T | " | | | | " |

REF STBSTATIC4C.DOT (W/ HINGE @ 7)

THESE MOMENTS & SHEARS ARE FICTITIOUS, SEE CALC'S

R./BLUME
ssue Street (at New Montgomery)
ancisco, California 94105

6 TO 10' SPACING W/HINGE @ 7

SHEET NO. 14
JOB 0 8438 BY BBB DATE 11-84
SUBJECT BRYANT ST. BETWEEN 2ND & BEALE CHK'D DATE

RESPONSE SPECTRUM ANALYSIS RESULTS*

| FLOOR | CASE / LOCATION | LONGITUDINAL MOMENT | LONGITUDINAL SHEAR | TRANSVERSE MOMENT | TRANSVERSE SHEAR | AXIAL |
|---|---|---|---|---|---|---|
| | 1 Bottom | 0 | 106 | 0 | 466 | 339 |
| 2 | Top | 2692 | 100 | 11867 | 441 | |
| | 2 B | 0 | 208 | 0 | 240 | 304 |
| | T | 5241 | 192 | 6098. | 226 | |
| | 1 B | 0 | 251 | 0 | 528 | 559 |
| | T | 5750 | 241 | 12074 | 507 | |
| | 2 B | 0 | 601 | 0 | 295 | 724 |
| | - | 13676 | 570 | 6735 | 282 | |
| | 1 B | 0 | 257 | 0 | 425 | 567 |
| 1 | T | 5138 | 247 | 8399 | 395 | |
| | 2 B | 0 | 525 | 0 | 304 | 595 |
| | T | 10450 | 497 | 5998 | 282 | |
| | 1 B | 0 | 298. | 0 | 572 | 532 |
| | T | 5170 | 284 | 9877 | 548 | |
| | 2 B | 0 | 616 | 0 | 438 | 586 |
| | T | 10647 | 591 | 7560 | 419 | |
| | 1 B | 0 | 258 | 0 | 1255 | 389 |
| | T | 3757 | 252 | 18343 | 1240 | |
| | 2 B | 0 | 496 | 0 | 614. | 411 |
| | T | 7167 | 478 | 8941 | 601 | |
| | 1 B | 0 | 330 | 0 | 4.4 | 425 |
| | T | 3911. | 327 | 0 | 5.5 | |
| | 2 B | 0 | 516 | 0 | 3.8 | 358. |
| | T | 6074 | 504 | 0 | 4.7 | |

*REF SABSEBAB4C.OUT (W/ HINGE @ 7)

RS/BLUME
Dussie Street (at New Montgomery)
San Francisco, California 94105

0 TO 10' SPECTRA W/WINDOW @ 7

SHEET NO. 15
JOB NO. 8458 JOB
BY EFB DATE 11-84
SUBJECT BRYANT ST. BETWEEN 2ND & BEALE
CHK'D DATE

STATIC (1.0) + RESPONSE SPECTRUM (1.0) RESULTS

| FLT | CHK LOCATION | LONGITUDINAL MOMENT | LONGITUDINAL SHEAR | TRANSVERSE MOMENT | TRANSVERSE SHEAR | AXIAL |
|---|---|---|---|---|---|---|
| 2 | 1 BOTTOM | 0 | 170 | 0 | 472 | 32. T |
| | TOP | 4371 | 164 | 12031 | 447 | 773. C |
| | 2 B | 0 | 272 | 0 | 246 | 67 C |
| | T | 6920 | 256 | 6265 | 232 | 738 C |
| 3 | 1 B | 0 | 351 | 0 | 548 | 78 T |
| | T | 8068 | 341 | 12534 | 527 | 1096 C |
| | 2 B | 0 | 701 | 0 | 315 | 243 T |
| | T | 15994 | 670 | 7195. | 302 | 1261 C |
| 4 | 1 B | 0 | 376 | 0 | 442 | 99 T |
| | T | 7556 | 366 | 8739 | 412 | 1084 C |
| | 2 B | 0 | 644 | 0 | 321 | 127 T |
| | T | 12868 | 616 | 6338. | 299 | 1112 C |
| — | 1 B | 0 | 443 | 0 | 574 | 74 T |
| | T | 7715. | 434 | 9914. | 550 | 1032 C |
| | 2 B | 0 | 761 | 0 | 440 | 128 T |
| | T | 13192 | 736 | 7597. | 421 | 1086 C |
| 0 | 1 B | 0 | 447 | 0 | 1273. | 71. C. |
| | T | 6533. | 441 | 18600. | 1258 | 884. C |
| | 2 B | 0 | 685 | 0 | 632. | 49 C |
| | T | 9943. | 667 | 9198. | 619. | 906 C |
| 1 | 1 B | 0 | 636 | 0 | 4. | 128 C |
| | T | 7547 | 633 | 0 | 6. | 1006 C |
| | 2 B | 0 | 822 | 0 | 4. | 195 C |
| | T | 9710. | 810 | 0 | 5. | 939 C |

RC: STBSTATIC 4C.OUT
STBSEISAB4C.OUT

THESE 2 COL'S INCLUDE FICTITIOUS STATIC RESULTS, SEE CALC'S

JB
4B

EVALUATION OF COLUMNS

HINGE STRONG AXIS $M_{CAP} = 1000$ SEE BELOW

BENT 7 CASE 1
16 #11 48"x48"

$M_{BL} = 9835^{k'}$ $\mu = 7$ P: 142 T
$M_{BT} = 10487^{k'}$ $\mu = 3.3$ 1276 C

HINGE, $M_{CAP} = 0$

@ P = 142 TENS
@ P = 1276 COMP.

$M_{CAP} = 1400^{k'}$ (16 #11)
$M_{CAP} = 3175^{k'}$
of Column SECTION

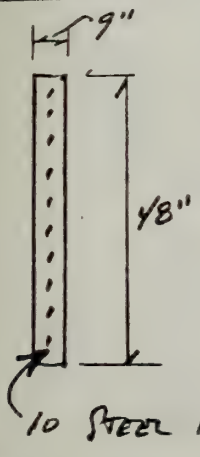
HOWEVER BENT 7 IS PINNED IN STRUCT LONGIT DIRECTION. HINGE DETAIL PROVIDES UNCERTAIN CONNECTIVITY FOR TRANSVERSE MOMENT & SHEAR.

⇒ ESTIMATED UPLIFT CAPACITY OF COLUMNS:

R/C SPREAD FTG - 2'x8'x8' x 150pcf = 19.2 k
SOIL (2' x 10'x10' - 4'x4') x 90 pcf = 16.5 k
35.7 k

TENSION LOADS IN EXCESS OF 35.7k AT BASE OF COL'S WILL PRODUCE UPLIFT.

PROPERTIES OF HINGE: (SEE INTERACTION DIAGRAM)




STRONG AXIS CAPACITY:
@ P = 100k T M = 1250 k'
@ P = 1276k C M = 950 k'
USE 1000k' = $M_u$ BOTH T & C

WEAK AXIS CAPACITY ≃ 0

CLEAR SPAN OF HINGE TO GROUND ≃ 13' (TO BOTTOM OF SPREAD FOOTING)
$V_{PL}$ = 1000k'/13' = 77k per column.

BENT 7 CONT'D

CASE 2 LOADS:

$M_{BL} = 11462$ ← $\mu = 8.2$ $P = \begin{cases} 48 & C \\ 1086 & C \end{cases}$

$M_{BT} = 5004$ ← $\mu = 1.64$

(16N11) HINGE, $M_{CAP} = 0$

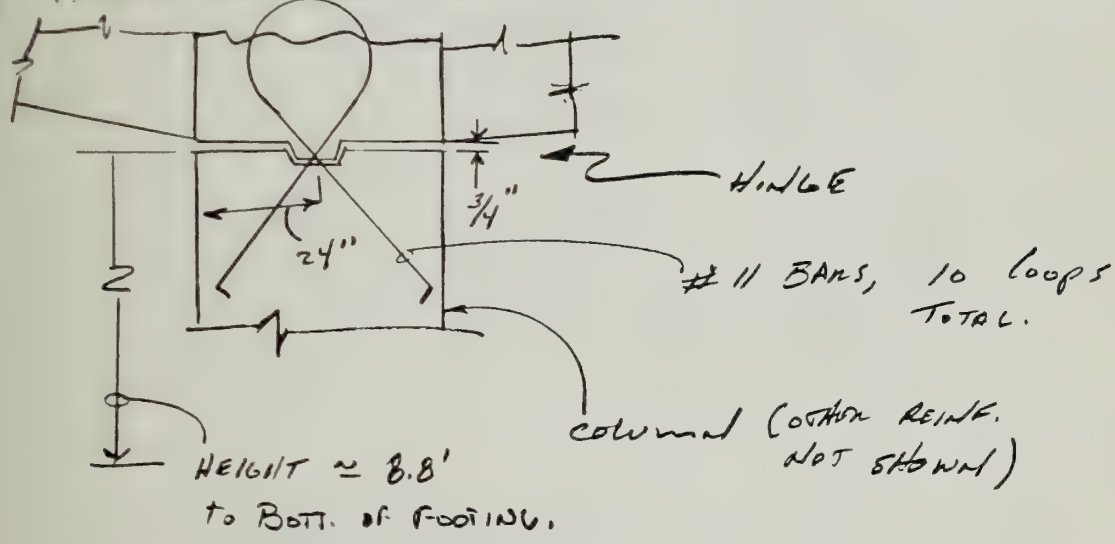
HINGE S.A., $M_{CAP} \doteq 1000$, ← SEE NEXT PAGE

@ $P = 48$, USE $M_u = 1400$

@ $P = 1086$ $M_u \doteq 3050$

DUE TO PRESENCE OF COMPLETE HINGE BENT TRANSVERSE, & PARTIAL HINGE BENT LONGIT, FORCES WILL REDISTRIBUTE FROM THIS SECTION TO OTHER BENTS. TO ACCOUNT FOR THIS ADDITIONAL STATIC & RESPONSE SPECTRUM RUNS HAVE BEEN MADE.

NOTE: DEPENDING UPON THE AMMOUNT OF DISPL, THE CLEARANCE PROVIDED @ THE HINGE COULD BE REDUCED SUFFICIENTLY TO MOBILIZE SOME MOMENT CAPACITY THROUGH THE WEAK AXIS OF THIS HINGE. SEE BELOW




$\theta = \frac{.75''}{24''} = 0.0313$ RAD

$\Delta_{COL\ BOTTOM} = 8.8' \times 12 \times 0.0313 = 3.3''$

∴ @ 3.3" OF DISPL (LONGIT.) WILL MOMENT TRANSFER THROUGH HINGE WILL BEGIN TO OCCUR.

MAX $\Delta_{RESPONSE\ SPECTRUM}$ = 0.27" (REF STBSEISAB4/C.OUT)

<< 3"

USE HINGED RESULTS.

BENT 7 CONT'D

FROM REVISED ANALYSIS (W/ HINGE @ 7):

SEE BELOW

MOMENT THROUGH HINGE STRONG AXIS = 3636, STATIC
= 3911 CASE 1 R.S.
= 6074 CASE 2 R.S.

NOTE: 3636 $^{k'}$ MOMENT FROM STATIC ANALYSIS IS FICTITIOUS / CAUSED BY SPAN ELMTS BEING CENTERED ON BENT IN MATHEMATICAL MODEL // ACTUALLY SPANS IN THE OTHER DIRECTION BEING SUPPORTED BY GIRDERS @ EDGE OF ROADWAY.

∴ THIS MOMENT WILL BE NEGLECTED.

USE IN PLACE $M = wL^2/12$

SLAB = 9" — TRIB WIDTH = 11'-1 3/4

GIRDER 24" w × 7'-6" d (6'-9 w/o SLAB)
INC. 9" SLAB

$w = \frac{9}{12} \times 11.15' \times .15$ KCF + $2' \times 6.75' \times .15 = 3.28$ KLF

$l = 42.5'$ (SAME AS COMPUTER MODEL)

$M = 3.28 \times \frac{42.5^2}{12} = 494^{k'}$

$M_{STATIC} = 494^{k'}$

USING Z = 7

$M = \frac{6074}{7} + 494^{k} = 1362^{k'} > 1000.$

HINGE IS OVERSTRESSED @ BENT 7

BENT 7, CONT'D

SHEAR

BENT LONGIT 969$^k$
BENT TRANS 726$^k$
(WORST CASE)
" "
w/o HINGE, VERY CONSERV.

$2\sqrt{f'_c} = 2(2500)^{1/2} = 100$ psi

$\phi bd = 0.85 \times 48'' \times 45'' = 1836$ in$^2$
USE d TO KEEP SHEAR CK CONSERVATIVE

$1836$ in$^2 \times 100$ psi $= 183^k$.
∴ STIRRUPS RQ'D (#3 @ 18" PROVIDED)

$v_u = \frac{969000}{1836} = 528$ psi  $v_u - v_c = 428$ psi $= 8\sqrt{f'_c}$

TOTAL RESPONSE SPECTRUM SHEAR CALCULATED W/o THE HINGE @ 7 IS TO HIGH, HOWEVER MAY REDUCE TO MAXIMUM ATTAINABLE SHEAR: $M_p/L$

STRONG AXIS HINGE $M_p$

TO BE CONSERV. SAY $M_p = 1250^{k'}$  $\frac{1250}{8.8'} = 142^k < 183$

SHEAR IN HINGE: $0.85 \times .8 \times 48'' \times 9'' \times 100$ psi $= 29.4^k$
NOT REPRESENTATIVE OF DIAG. TENSION HOWEVER,

USE SHEAR FRICTION; USE $\mu = 1.0$  $v_u = 142^k / .85 \times .8 \times 48 \times 9 = 483$ psi

$0.2f'_c = 500$ psi $> 483$. ✓  $V = 0.85 \times 40_{ksi} \times 29.6$ in$^2$ $\times 1.0 = 1006^k > 142$ ok
(20 #11)

(IF ½ OF BARS NOT EFFECTIVE, CAP = 500 ok)

CONCLUSION: COLUMNS @ BENT 7 MEET ACCEPTANCE CRITERIA, HINGE @ TOP OF COLUMNS (STRONG AXIS OF HINGE) IS OVERSTRESSED.

BENT NO 6 COL #10 56 #11 (WEST COL)
COL #11 20 #11 (EAST COL)

LOAD CONDITION 1 - IDEALIZATION W/HINGE @ BENT 7

$M_{L_S} = 2776^{k'}$ $V = 189^k$ $M_{T_S} = 257$ $V = 18$

$M_{L_E} = 3757^{k'}$ $V = 252^k$ $M_{T_E} = 1834/3$ $V = 12\frac{1}{2}0$

$M_{LONGIT\ STATIC}$ IS A FICTITIOUS MOMENT, USE $M = wL^2/12 = 494^{k'}$
$\Rightarrow$ SEE NOTE CONCERNING $M_{L_S}$ FOR BENT 7

USING $Z = 7$ (SLIGHTLY MORE THAN REASONABLE, CK LIMITING CASE)
$M_{L_{DESIGN}} = 1031^{k'}$ $M_{T_D} = 2877^{k'}$

FROM R.S. ANALYSIS

SEE NEXT SHEET FOR STATIC AXIAL LOADS

$P_{E_{20\#11}} = 351 \times 1.3 = 456^k > 389$ USE $389^k$ FOR BOTH.

$P_{E_{56\#11}} = 376 \times 1.3 = 489^k > 389$

STATIC CTR

$460 - 389 = 71^k$ C

$460 + 389 = 849^k$ C

$\frac{1031}{2190} + \frac{2877}{3040} = 0.47 + 0.95 = 1.42 > 1.0$ 20 #11
N.G.

$\frac{1031}{4900} + \frac{2877}{5900} = 0.21 + 0.49 = 0.70$ 56 #11

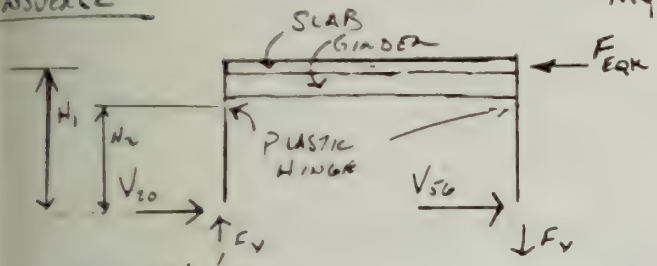
BENT 6, CONT'D

USE PLASTIC MOMENT TO DETERMINE SHEARS & AXIAL LOAD IN BENT.

$P_{DL} = 460^k$ TRY $M_y = 2750^{k'}$ (20 # 11)

$M_y = 5500^{k'}$ (56 # 11)

TRANSVERSE




$V_{20} = \frac{2750}{H_2} = 250^k$

$V_{56} = \frac{5500}{H_2} = 500^k$

$750^k$

(DOES NOT INCLUDE SHEAR FROM STATIC ANALYSIS)

$H_1 = 18\frac{1}{2}' \pm$

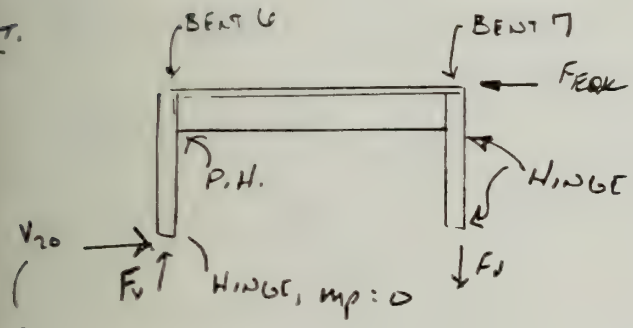
$H_2 = 11' \pm$

$F_{EQK} = 750^k$

$M_{BASE} = 750 \times 18\frac{1}{2}' = 13875^{k'}$

$F_V = 13875^{k'}/42.5' = 326^k$

LONGIT.




$V_{20} = \frac{2750}{H_2} = 250^k$

$F_{EQK} = 250$

$M_B = 250 \times 18\frac{1}{2} = 4625^{k'}$

$F_V = 4625/55.25' = 84^k$

or FOR $V_{56}$; $F_V = 168^k$

AXIAL, CASE 1 = $326 + 0.3(84) = 351^k$
CASE 2 = $0.3(326) + 84 = 182^k$
} "PLASTIC" AXIAL FROM EQK LOADS, 20 # 11

AXIAL CASE 1 = $326 + 0.3(168) = 376.4^k$
CASE 2 = $0.3(326) + 168 = 265.8$
} "PLASTIC" AXIAL FROM EQK LOADS, 56 # 11

NOTE: TO GET VALUES FOR "PROBABLE PLASTIC MOMENT", MULTIPLY ABOVE AXIAL LOADS BY 1.3

FENT 6 CONT'D

CHECK SHEAR IN COLUMNS:

$V_{PLASTIC}$ = 250k $v_u = \frac{250000}{(0.85 \times 48 \times .8 \times 48)}$ = 159 PSI
20# 11 $\times 1.3 = 325^k$ $v_u - v_c = 59$

$V_{PLASTIC}$ = 500k $v_u$ = 319 PSI $v_u - v_c$ = 219 } SPLICE @ d ok
50# 11 $\times 1.3 = 650^k$

$0.85 \times 48 \times 0.8 \times 48 \times 2(2500)^{1/2}$ = 157.k < 250
(w/ $\phi$ = .85) = 184k) < 500

STIRRUPS RQ'D, # 3 @ 18 PROVIDED

$V_s = \frac{0.22 \times 40000 \times 44}{18''}$ = 21.5k

MUST USE MORE ACCURATE ANALYSIS FOR $V_c$

SHEAR & AXIAL ONLY (NO TENSION)

$V_c = \left(1.9(2500)^{1/2} + 2500(.01402)\frac{250}{2750 \times 12} \times 44\right) 48 \times 44$ = 225k (20#11)
(ρw)

$V_c = \left(1.9(2500)^{1/2} + 2500(.03083)\left(\frac{500}{5500 \times 12} \times 44\right)\right) \times 48 \times 44$ = 255k (56#11)
106.7 120.7 .23 < 1 ok
FOR 44 # 11

INCLUDING AXIAL COMPRESSION: — MIN = 71k

$V_c = \left(1.9(2500)^{1/2} + 2500(.01402)\left(\frac{250 \times 44}{1436 \times 12}\right)\right) 48 \times 44$ = 248k
117.4
$m_m = 2750 - 71\left(\frac{4(48) - 44}{8}\right) = 1436$
+ 21.5
269.5k < 325 (20#11)

$V_c = 0.9(2500)^{1/2} + 2500(.03083)\left(\frac{500 \times 44}{4186 \times 12}\right)) 48 \times 44$ = 272k
178.7
$m_m = 5500 - 71\left(\frac{4(48) - 44}{8}\right) = 4186$
+ 43
315k < 650 (56#11)

LIMIT ON $V_c$ W/ 500k
$V_c = 3.5(2500)^{1/2} \times 48 \times 44 \times \left(1 + \frac{500000}{500 \times 48 \times 48}\right)^{1/2}$ = 444k < 650
STILL N.G.

BENT 6 CONT'D

THE COLUMNS AT BENT 6 ARE NOT CAPABLE of RESISTING SHEAR NECESSARY TO DEVELOP PLASTIC HINGE @ TOP OF COLUMN. THIS IS TRUE FOR BOTH COLUMNS (20 #11 & 56 #11).

LOAD CONDITION 2 EXCEEDS PLASTIC CAPACITY of COLUMNS ALSO, BY INSPEC. SHEAR WILL NOT WORK.

USE OF "Z" FACTOR IS NOT APPROPRIATE* SINCE SHEAR LIMITS THE CAPACITY OF THE COLUMNS TO A DUCTILITY VALUE LESS THAN 1.0

RETROFIT REQ'D

* i.e. - "Z" SHOULD BE LIMITED TO 1.0 FOR THIS CONDITION. GIVEN THIS LIMITATION, COLUMNS ARE EXTREMELY OVERSTRESSED.

DETERMINING AMMOUNT OF SHEAR REINF. REQ'D to CARRY 650$^k$

$V_c$ @ 100psi (2$\sqrt{f'_c}$) = 0.85 × 48 × .8 × 48 × 100 psi = 156$^k$

650 − 156 = 494$^k$ = $V_s$

TRY # 9 STIRRUPS, $A_v$ = 1.0 + 1.0 = 2.0 in$^2$

$494000 = \frac{2.0 \times 60000 \times 44}{s}$ (s = SPACING) $s = 10.7''$

TRY # 6 STIRRUPS

$494000 = \frac{0.88 \times 60000 \times 44}{s}$ $s = 4.7''$

min REQ'D = 50 × 48 × 4½" / 60 000 = 0.18 in$^2$ < 0.44 ok
" " 10" / 60 000 = 0.48 in$^2$ < 2.0 ok

NEED # 9 @ 10"
or # 6 @ 4½"
# 7 @ 6"

BENT NO. 5

56 No. 11

LOAD CONDITION 1

$M_{L_E} = 5170^{k'}$

$M_{T_E} = 9877^{k'}$

$P_{EQK} = 532^k$

$P_{EQK + STATIC} = \begin{cases} 74^k & T \\ 1032.^k & C \end{cases}$

$M_Y = 4900^{k'}$ @ $P = 0$

$= 6000^{k'}$ @ $P = 1000$

PLASTIC SHEAR $= \frac{4900}{16'} \times 1.3 = 398^k$ (+ STATIC V)

$\frac{6000}{16} \times 1.3 = 487^k$ (+ STATIC V)

SHEAR CAPACITY of BENT 5 COL'S $\leq$ SHEAR CAP. of COL W/ 56 #11 FROM BENT 6 $= 255^k$ (VALUE W/o COMP.)

$487 > 255$

$\therefore$ NOT CAPABLE of DEVELOPING PLASTIC HINGE

THIS IS SIMILARLY TRUE of BENTS 2, 3 & 4.
i.e.- CANNOT TRANSMIT SUFFICIENT SHEAR TO YIELD COLUMNS @ TOP,
$\therefore$ CANNOT DEVELOP PLASTIC HINGE W/o FAILING IN SHEAR.

$\therefore$ A "Z" VALUE (7/10) MAY NOT BE USED SINCE COLUMN DUCTILITY IS LIMITED TO LESS THAN 1.0.

$\therefore$ RETROFIT OF STRUCTURE IS REQUIRED.

Columns - Bearing check base for vert. load

Largest Axial Load Static = 581$^k$ (@ Bott, Bent 7)
Largest " " - Response Spectrum = 724$^k$ Bent 3
695 Bent 7

Ck Bent 7, max Comp. = 581+695 = 1276$^k$
— Below Balance Point for Col Section.

Footing Size = 4'-0 x 6'-0 = 24 ft$^2$
Allowable Recommended By Soils Investigation:
(Allstate Geotechnical Services - Sept 1984).
5000 psf + 1/3 increase for Seismic & Transient Loading.

Allow Static = 5000 psf x 24 ft$^2$ = 120 000$^{\#}$ = 120$^k$
← w/o Live Load
581/120 = 4.84 over for Static.
>1.0

EQK - 120$^k$ x 1.33 = 160$^k$
1276/160 = 8.0 over for Static
>1.0 + Resp. Spectrum.

Try Typ. Col - Bent 3
$P_{STATIC}$ = 500$^k$
$P_{EQK}$ = 559
1059

FTG = 8' x 8' = 64 ft$^2$
64 x 5. ksf = 320$^k$
320 x 1.33 = 426$^k$
← w/o Live Load

Static - 500/320 = 1.56 >1.0 over Allow
Static+EQK = 1059/426 = 2.49 >1.0 over Allow

This structure has been in place for ~34 years & has shown no distress due to vertical load. (This structure is situated on Bedrock). ⇒ Conclude - Allstate Geotech. Services Recommended Allowable Bearing Value is Grossly Conservative. (See Following Page)

EXCEEDANCE OF BEARING ALLOWABLE ON BEDROCK* WILL NOT CONSTITUTE A HAZARD TO LIVE SAFETY. ⇒ (ESPECIALLY IF PUNCHING SHEAR IS OK — FTG WILL NOT BREAK UP)

ck PUNCHING SHEAR 8'x8' FTG, 4'x4' col, 2' THICK

$24'' - 3''_{cover} - 1'' = 20''$ — USE FOR d

$48'' + d/2 + d/2 \times 4 = 68 \times 4 = 272''$

$272'' \times 20'' = 5440\ in^2$

$4\sqrt{f'_c} \times 5440 = 200 \times 5440 = 1088^k$

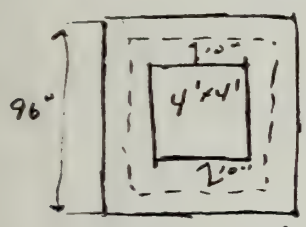
NOTE: $\phi = 1.0$ USED.

TOTAL $P_{xn} = 1059$

IF LOAD IS UNIFORMLY SUPPORTED @ BASE:

$1059^k / 64\ ft^2 = 16.6\ KSF$

AREA OF REGION OUTSIDE OF PUNCHING SHEAR SECTION,




$96 - 48 - 10 - 10 = 28''$
(14" EA SIDE)

PERIMETER = 272"

$A_{OUTSIDE} = 96'' \times 14'' \times 2 + (96 - 28)(14) \times 2$
$= 4592\ in^2 = 32\ ft^2$ (½ AREA OF TOTAL FOOTING)

LOAD $= 1059/2 = 529^k$

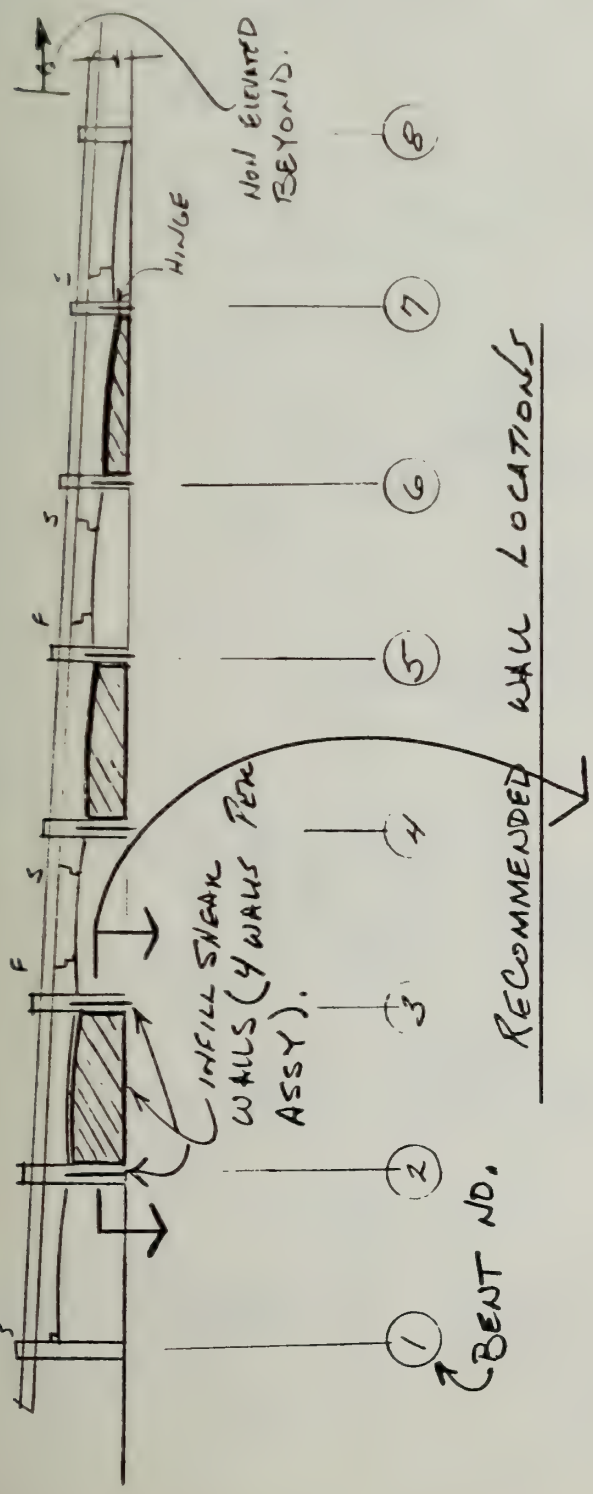
$529^k << 1088^k$

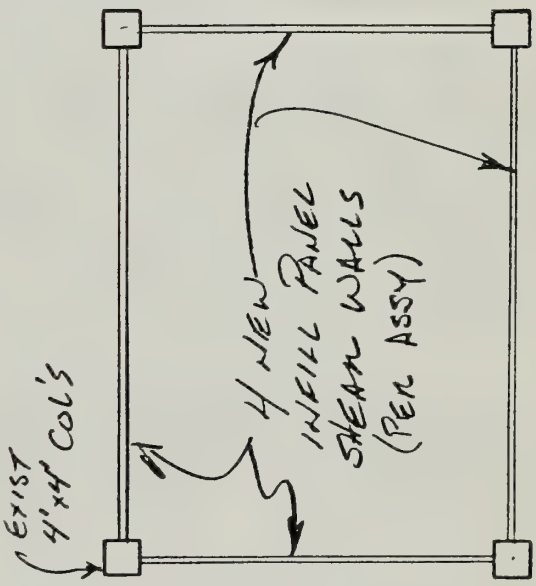
CONCLUDE: BEARING LOADS ARE ACCEPTABLE, IGNORE BEARING VALUE GIVEN BY ALLSTATE GEOTECH.

* SEE BORING DH-8 — DONE BY ALLSTATE GEOTECHNICAL SERVICES, 1984

RECOMMENDED RETROFIT :

ADDITION OF INFILL SHEARWALLS AT APPROPRIATE LOCATIONS WILL BE EFFECTIVE IN ELIMINATING SHEAR IN COLUMNS




SECTION - TYP 3 PLACES

LETMOCIT, CONT'D

ESTIMATED WALL SIZES:

DUE TO ADDITION of THESE WALLS, STRUCTURE STIFFNESS WILL INCREASE & FREQUENCIES BELOW THE PEAK WILL INCREASE, RATHER THAN RE-RUNNING THE ANALYSIS, BASE WALL SHEAR. of 1.315 g (SPECTRAL PEAK) TIMES THE SUPERSTRUCTURE MASS.

TYP. BENT:

LONGIT SUPPORTS ~ 3 FULL SPANS LESS 11'

$l = 55.3' \times 3 - 11 = 154'$

@ $16.72^k/'$ → $154' \times 16.72 = 2575.9^k$

$1.315g \times 2575^k \rightarrow 3386^k$ SHEAR (2 WALLS)

$3386/2 = 1693$

$l_{WALL} = 55.3' - 4' = 51.3'$

IF $\mu = 1$ IS USED, $t_{WALL}$ @ $6\sqrt{f'_c}$ : ($f'_{c_{NEW}} = 4000$)

$379\,psi = \dfrac{1693^k}{51.3' \times 12 \times t}$ $t = 7\frac{1}{4}''$ SAY $10''$ WALL

$\div .85 = 8\frac{1}{2}''$

RESONABLE.

ck TRANS. DIRECTION

ASSUME S.W. CARRY $1\frac{1}{2}$ SPANS

$55.3' \times 1.5 \times 16.72^k/' = 1388^k$ / 2 WALLS

$l_{WALL} = 42.5' - 4' = 38\frac{1}{2}'$

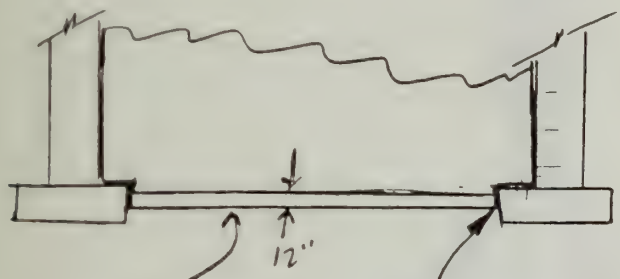
$379\,psi = \dfrac{1388^k}{38.5' \times 12 \times t}$ $t = 7.93''$ $\div .85 = 9.33''$ SAY 10" WALL

$W/\mu = 1.0$

NOTE SLIGHTLY MORE THAN 10" MAY BE REQ'D w/ MASS of WALL & COL'S ADDED in.

BASE DETAIL MUST BE PROVIDED TO MINIMIZE ADVERSE IMPACT ON COLUMNS. — COLUMNS TIED TOGETHER BY INFILL PANELS MUST DISPLACE TOGETHER @ BASE TO PREVENT WALL FROM LOADING COL'S IN HIGH SHEAR. RECOMMEND TYING COL'S TOGETHER THROUGH BASE & WALL

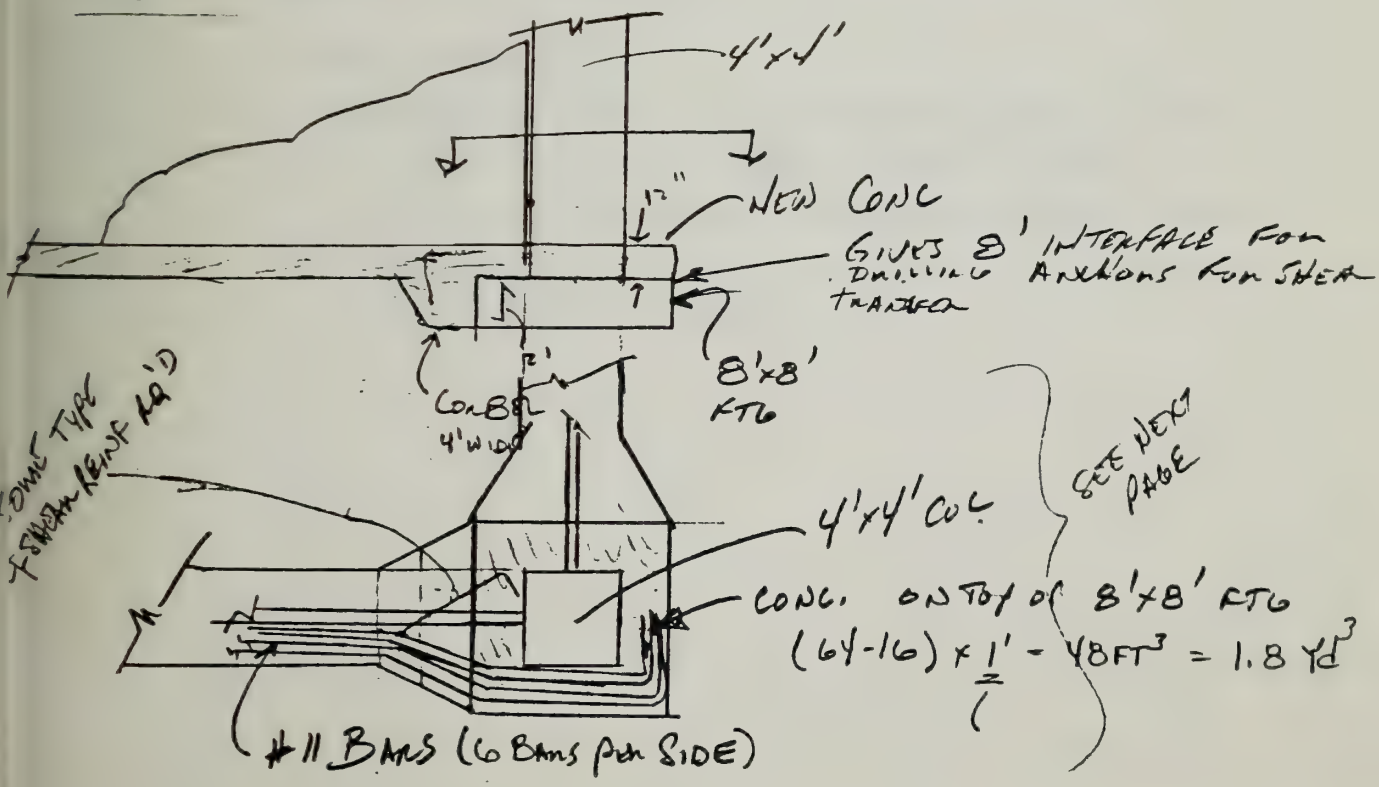
i.e. -



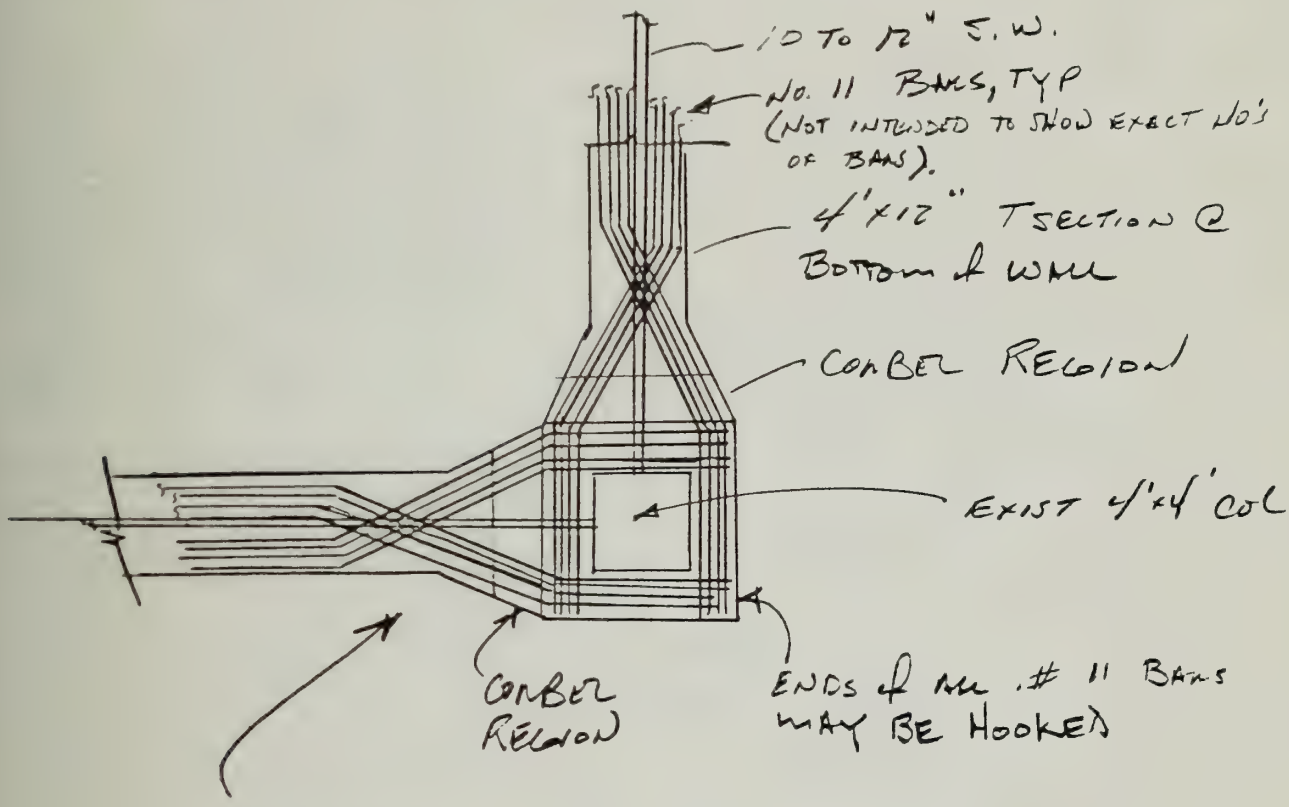

CONNECTION SHOULD BE CAPABLE OF TYING FOOTINGS TOGETHER

MIN SIZE
RQ'D ≅ 12" x 4'-0
W/ ≅ 12 #11 BARS

MAY BE EASIER TO DEVELOP LOADS THUS:



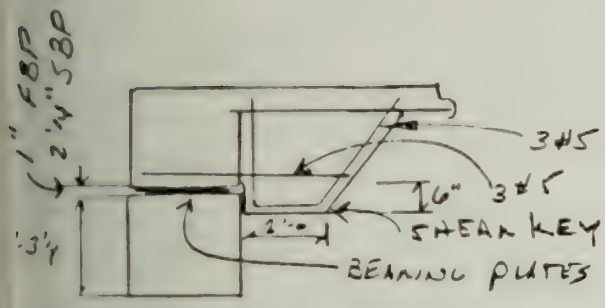
REINFORCING STEEL ALT 3:




ADVANTAGES:

① STEEL LAYOUT IS MORE STRAIGHTFORWARD
② ONLY NOMINAL SHEAR REINF REQ'D @ ENDS OF 12"x48" SECTION, THRUST FROM IS SELF EQUILIBRATING; SECTION LESS LIKELY TO BREAK UP.

CAPACITY OF TRANSVERSE SHEAR KEYS - PROVIDE @ HINGES




REF SECT D-D ON B-19708 REV 2/8-24-53

MINIMUM SHEAR KEY DEPTH = 6" − 2¼" = 3¾" } A = 56.25 in²
WIDTH = 15"

CONC. BEARING STRESS LIMITED TO 0.85 φ f'c
USE φ = 1.0
0.85 × 2500 = 2125 psi
2125 × 56.25 = 119.5 K

THIS IS A RATHER OPTIMISTIC APPRAISAL OF CAPACITY AS A 3¾" SHEAR KEY IS QUESTIONABLY EFFECTIVE.

D.L. of INTERIOR SIMPLY SUPPORTED SPAN SEGMENT BETWEEN HINGES: ~ 468 K

119.5 × 2 / 468 = 0.51 g RESISTANCE AVAIL, MAX
(239)

HINGE DEMAND SHEARS (TRANSVERSE TO BRIDGE ℄)

| HINGE | CASE 1 * | CASE 2 * |
|---|---|---|
| 1 | 97 K | 323 |
| 2 | 103. | 342. |
| 3 | 93. | 310. |
| 4 | 83. | 276. |
| 5 | 99. | 330. |

1 = 1.0 LONG + 0.3 TRANS
2 = 0.3 LONG + 1.0 TRANS

> 119.5 MUST SUPPLY ADDITIONAL TRANSVERSE SUPPORT.

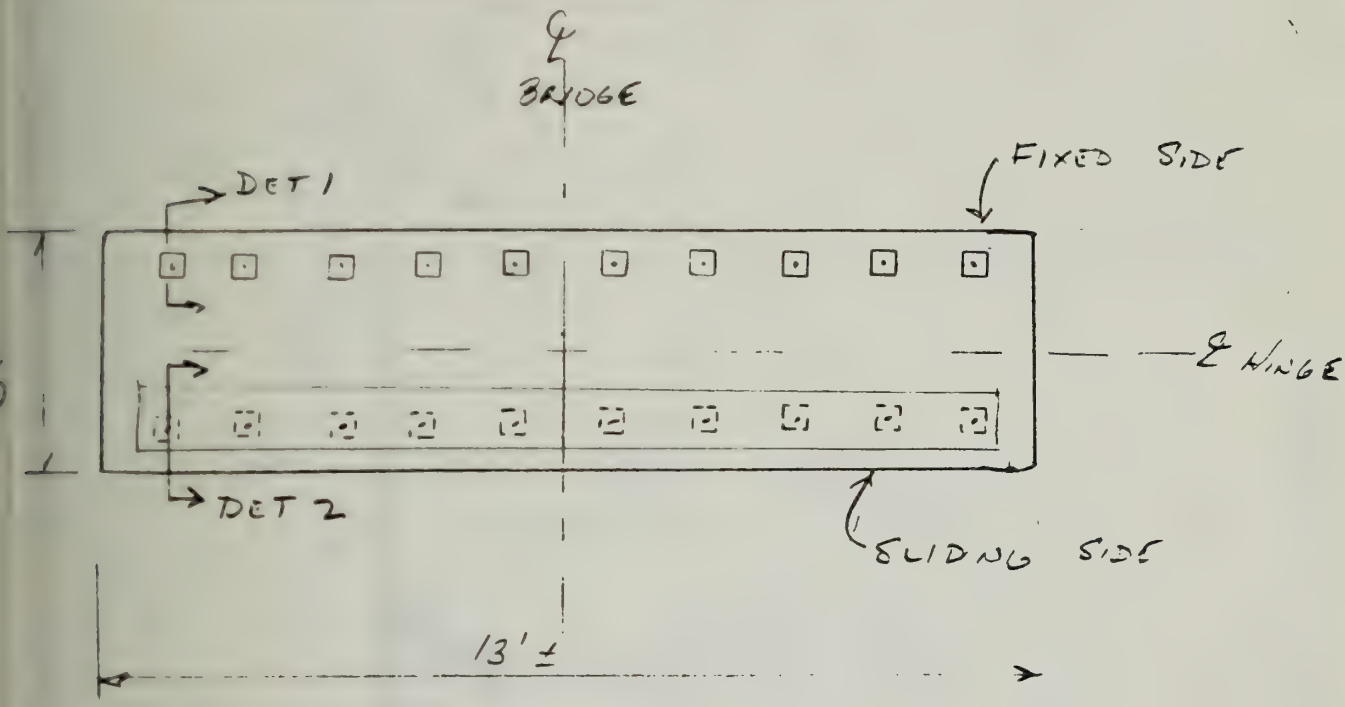
* REF 50BSEISAB4C.OUT

/BLUME
asie Street (at New Montgomery)
lancisco, California 94105

SHEET NO. 33

JOB 64?8 BY SDS DATE 12-24

SUBJECT BRYANT ST. BETWEEN 2ND & BEALE CHK'D DATE




QUANTITIES:

1" R 2½ × 13 = 32.5 FT² @ 40.83 #/FT² = 1327#

½" R 3½"×3½"×10 + 4¼×4¼×10 = 325 IN² = 2.26 FT² @ 20.4 #/FT² = 46#

5/8 BAR × ~26' 35#

3/8 R 7"× 12½' → 7.3 FT² @ 40.83 × 3/8 = 112#

1520#

USE 1^00 PER # FABRICATED

SAY 1500^00 (STEEL ONLY)

REMOVE PAVEMENT DOWN TO CONC DECK 4' × 16' (64 FT²)

REMOVAL - $1.54 / SF 64 × 1.54 = 98^00

REPLACEMENT - ONE COURSE 2" - 7.07/SY

64/9 × 7.07 = 50.3 × 7 = 352.-

NOT REASONABLE

7 HINGES @ 1500 → 10500. (STEEL ONLY)

PAVEMENT REMOVAL 4 MAN DAYS 32 HRS @ 50 → 1600.

2 days SMALL DUMP TRUCK @ 150/d 300

1900.

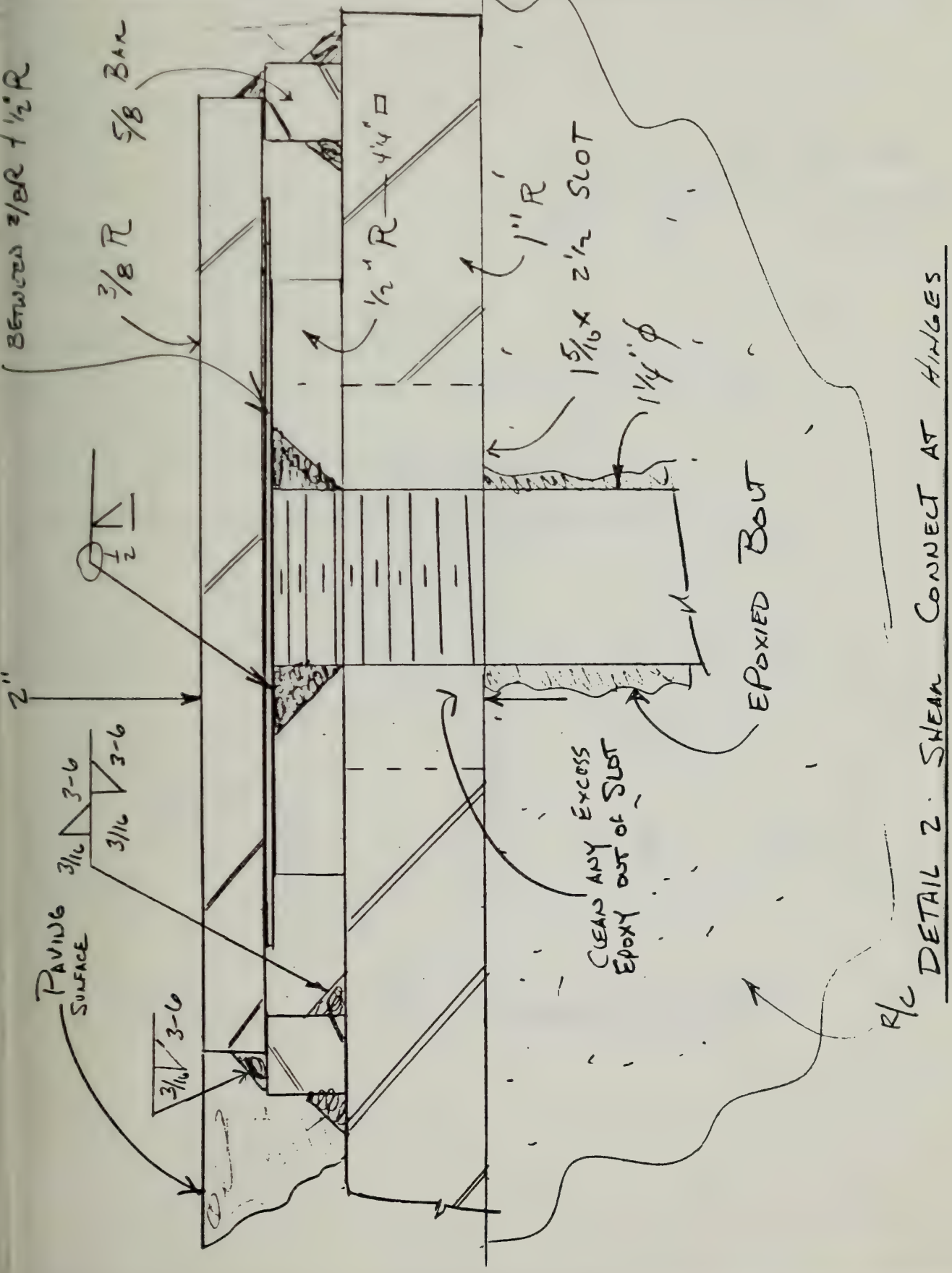
REPLACEMENT - USE 1000—

TOTAL 13400.

+ HOLES + EPOXY 16580.

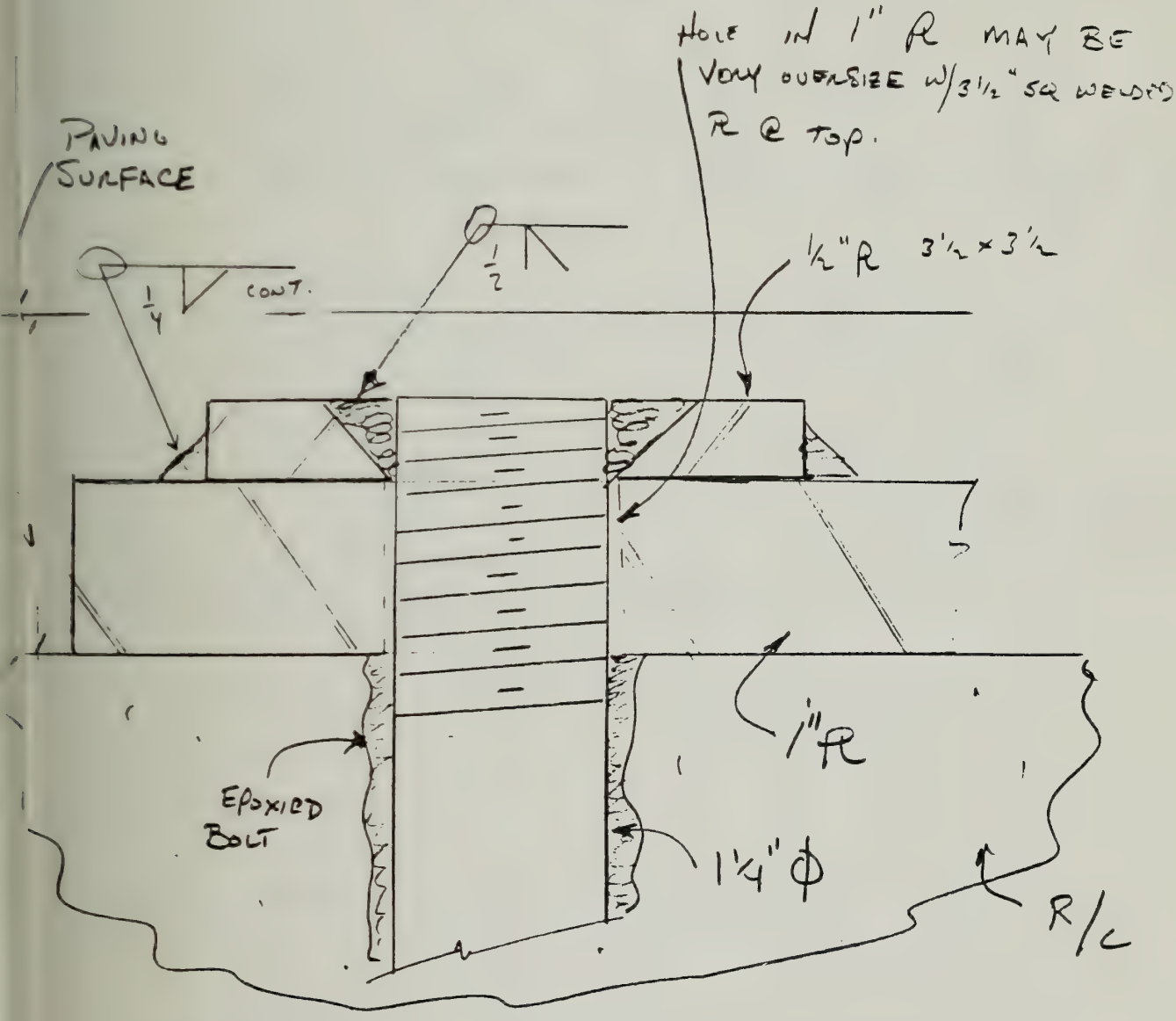
S/BLUME
Jessie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 34
JOB D 84-8
BY STB DATE 12-84
SUBJECT BRYANT ST BETWEEN 2ND & BEALE
CHK'D DATE



S/BLUME
Jesse Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 35
D. 84/38 JOB
BY [illegible] DATE 12-84
SUBJECT BRYANT ST. BETWEEN 2ND/4 BEALE
CHK'D DATE




DETAIL 1 - SHEAR CONNECT AT HINGES

BLUME
sie Street (at New Montgomery)
Fincisco, California 94105

SHEET NO. 36

N 5438 JOB | BY STB DATE

SUBJECT BRYANT BETWEEN 2ND & BEALE | CHK'D DATE

C.F. ESTIMATE

# SQ FT OF S.W. ~ 12' x (51.3+38½) x6x2 = 13000. FT²
(BOTH SIDES FOR FORMWORK)

C.Y. EXCAVATION:

TOP OF FTGS 4 Yd³ PER COL → x12 = 48 CY
FOR CORBELS: 2'x3'x8'x24 → 43 CY
FOR 'T' @ BOTTOM: 4'x2'x(51.3+38½ -8) x6 → 145 CY

236 CY

SOME OF THIS EXCAVATED MATERIAL WILL BE FRANCISCAN FORMATION BEDROCK (TYPE OF SANDSTONE).

REINF. STEEL - 12#10 (51.3+38½+24)x6 = 683
x12 BARS = 8200'
34,000 #

WALL STEEL - SAY #5 @ 12 EWEF
4 LF #5 / FT²
4 x 13000 = 52000 LF
54,000 #.

R.S. 0.65

DRILLED IN ANCHORS - 140 PER AVG WALL
x 12 WALLS = 1680 HOLES

BLUME
Street (at New Montgomery)
ncisco, California 94105

SHEET NO. 37
JOB 8438 BY EOB DATE 11-84
SUBJECT BRYANT BETWEEN 2ND & BEALE CHK'D DATE

CT ESTIMATE

EST. QUANTITIES FOR WALLS : USE 12' HT AVG.
(USING REINF. ALT NO. 3)

$12' \times 51.3' \times 10''/12 \times 6$ WALLS $= 3078$ FT$^3$

$12' \times 38\frac{1}{2}' \times 10''/12 \times 6$ WALLS $= 2772$ FT$^3$

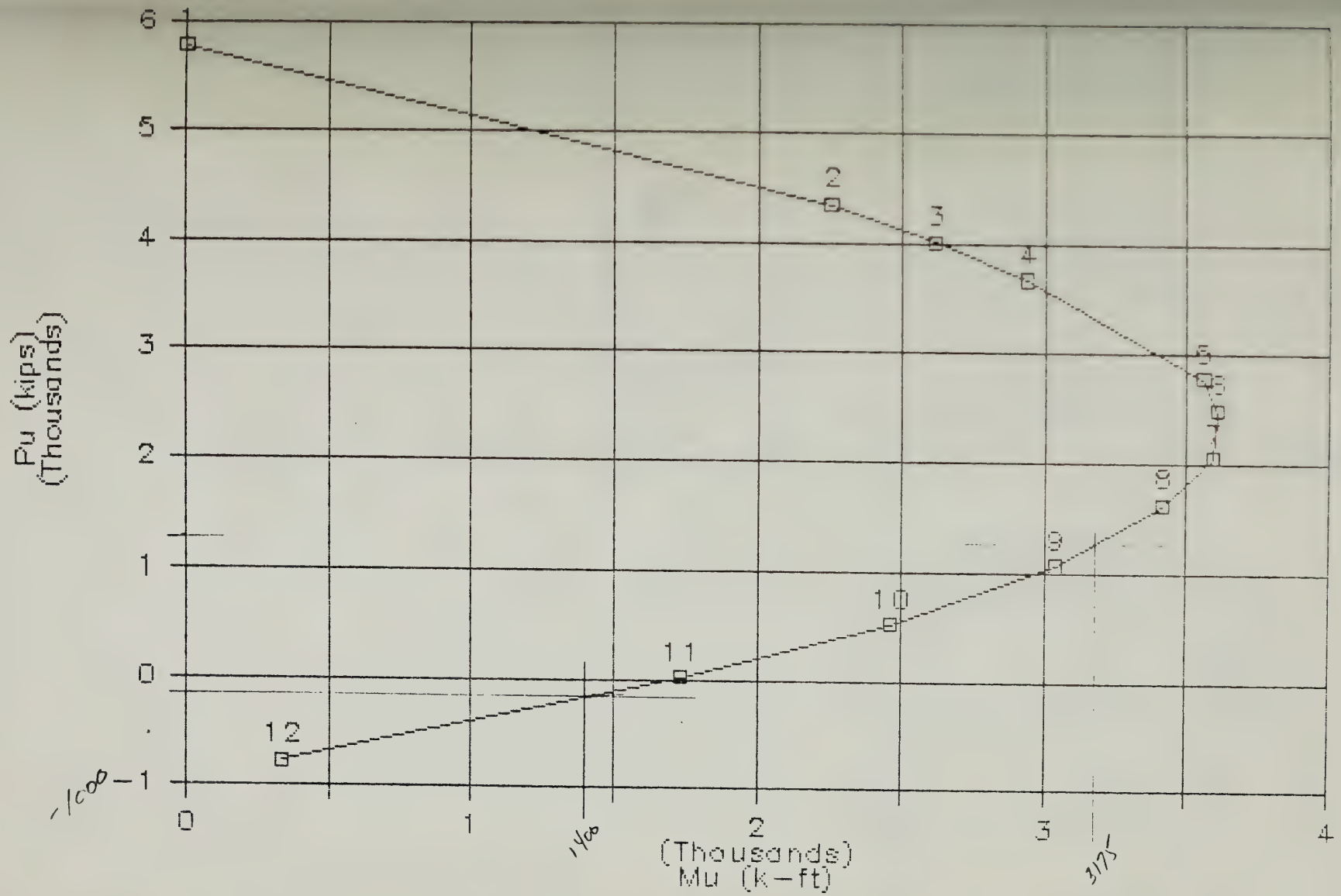
5850 FT$^3$

217 CY

COL. ON TOP OF EXIST FOOTINGS –
1.8 YD$^3$ × 12 COL'S 21.6 CY
CORBELS @ BASE 2'×3'×8'×24 ÷ 27 43. CY

"T" @ BOTTOM OF WALL:
1'-0 × 4'-0 × (51.3'×6 + 38½'×6) ÷ 27 = 80 CY
APPROX

362. CY




16 # 11 NON-REPCT.

BENT NO. 7

SJB
11-84

STB
11-84

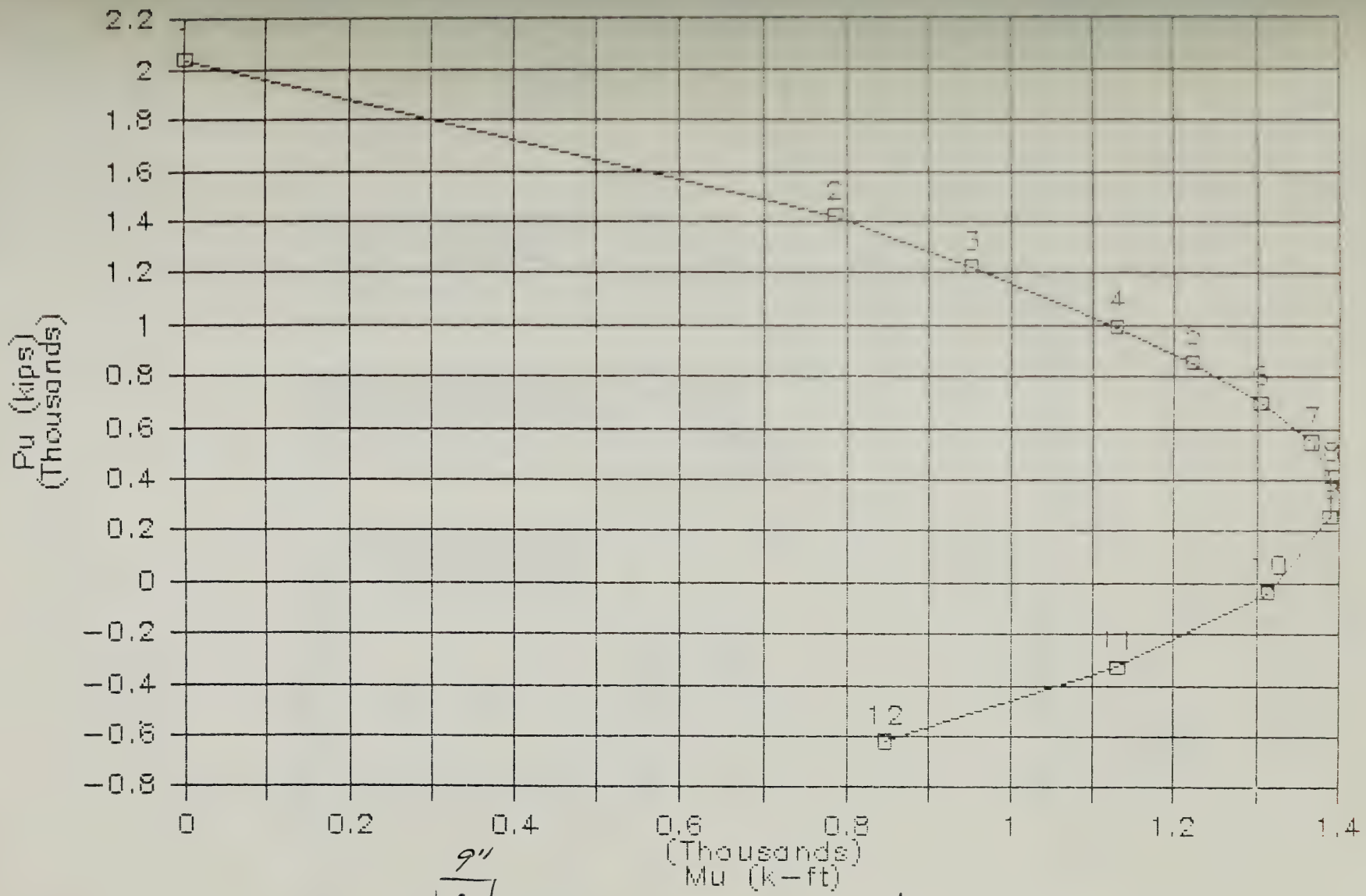
.= ( 29000 ) h= ( 48 ) RECTCOL
y= ( 40 ) b= ( 48 )
c= ( 2.5 ) B1= ( 0.85 ) COL: (TITLE )
ts : ksi Cb= ( 30.83 )

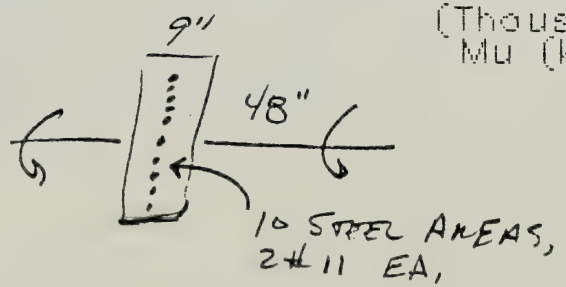
| t | Pu | Mu k-in | Mu k-ft | c | *steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 5792.9 | 0.0 | 0.0 | | * 1 | 3 | 7.4 |
| 2 | 4352.6 | 27070.9 | 2255.9 | 44.00 | * 2 | 13.5 | 2.96 |
| 3 | 4019.3 | 31391.5 | 2616.0 | 41.00 | * 3 | 24 | 2.96 |
| 4 | 3674.4 | 35233.0 | 2936.1 | 38.00 | * 4 | 34.5 | 2.96 |
| 5 | 2789.5 | 42726.7 | 3560.6 | 30.83 | * 5 | 45 | 7.4 |
| 6 | 2494.7 | 43280.6 | 3606.7 | 28.00 | * 6 | 0 | 0 |
| 7 | 2058.8 | 43116.7 | 3593.1 | 24.00 | * 7 | 0 | 0 |
| 8 | 1625.8 | 41034.7 | 3419.6 | 20.00 | * 8 | 0 | 0 |
| 9 | 1067.4 | 36470.6 | 3039.2 | 15.00 | * 9 | 0 | 0 |
| 10 | 524.3 | 29521.8 | 2460.2 | 10.00 | * 10 | 0 | 0 |
| 11 | 24.1 | 20776.5 | 1731.4 | 5.00 | * | | |
| 12 | -773.8 | 4014.2 | 334.5 | 2.00 | *[PgDn]:factored loads | | |
| | | | | | *F5 HELP [ENTER]: help | | |

16 #11

BENT No. 7

# Column Interaction Diagram




HINGE @ 7, STRONG AXIS

BTB
11-84

STB
11-84

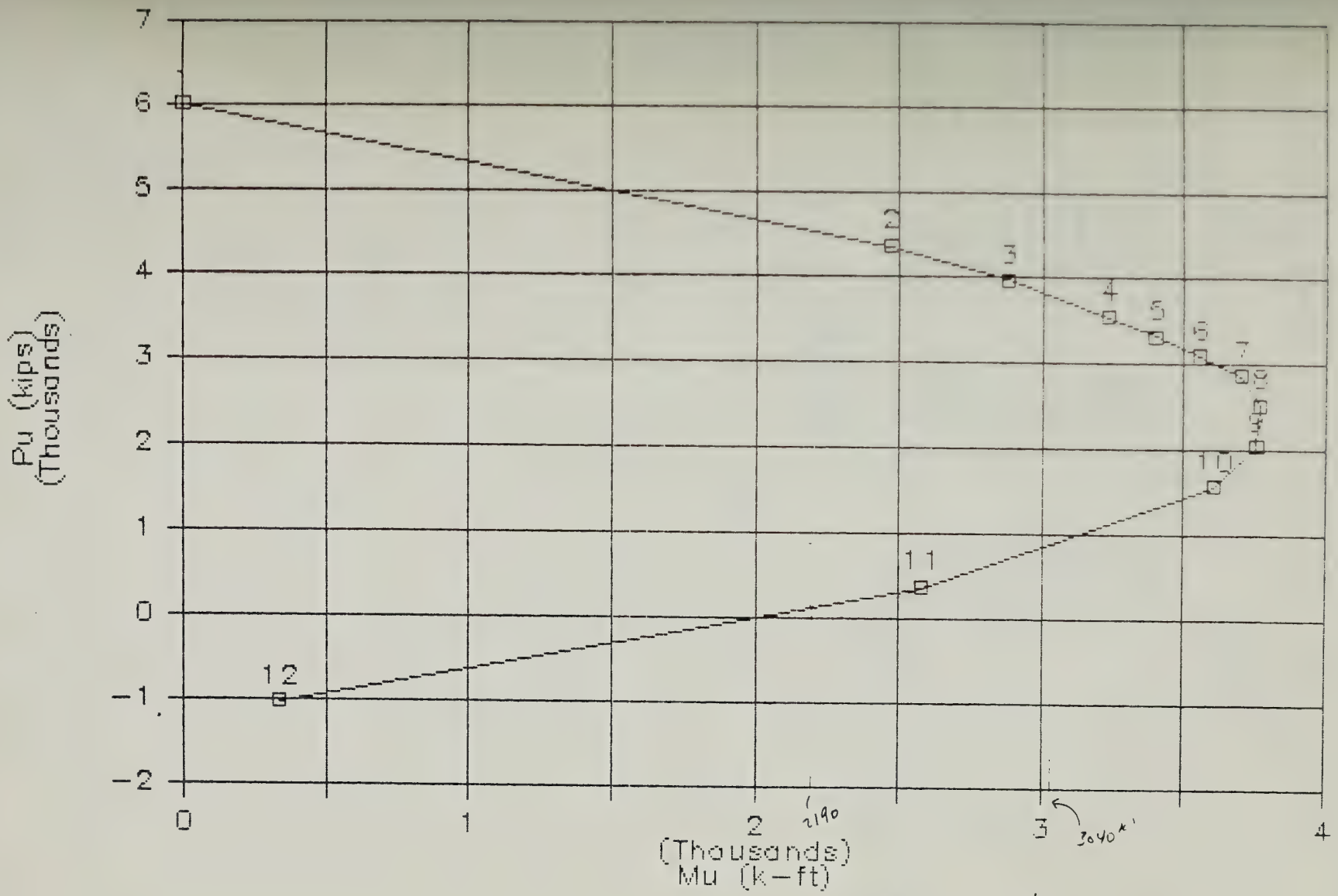
HINGE @ 7, STRONG AXIS

Es= ( 29000 ) h= ( 48 ) RECTCOL
fy= ( 40 ) b= ( 9 )
'c= ( 2.5 ) B1= ( 0.85 ) COL: ( 20 # 11 )
uits : ksi Cb= ( 26.83 )

| nt | Pu | Mu k-in | Mu k-ft | c | steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 2039.1 | 0.0 | 0.0 | | 1 | 4.5 | 2.96 |
| 2 | 1423.2 | 9433.8 | 786.1 | 41.65 | 2 | 8.83 | 2.96 |
| 3 | 1227.7 | 11426.5 | 952.2 | 37.42 | 3 | 13.17 | 2.96 |
| 4 | 993.0 | 13551.7 | 1129.3 | 33.18 | 4 | 17.5 | 2.96 |
| 5 | 855.3 | 14658.0 | 1221.5 | 31.07 | 5 | 21.83 | 2.96 |
| 6 | 702.6 | 15654.5 | 1304.5 | 28.95 | 6 | 26.17 | 2.96 |
| 7 | 548.9 | 16392.0 | 1366.0 | 26.83 | 7 | 30.5 | 2.96 |
| 8 | 413.2 | 16693.6 | 1391.1 | 24.72 | 8 | 34.83 | 2.96 |
| 9 | 261.2 | 16673.8 | 1389.5 | 22.60 | 9 | 39.17 | 2.96 |
| 10 | -36.4 | 15769.8 | 1314.1 | 18.37 | 10 | 43.5 | 2.96 |
| 11 | -328.3 | 13570.3 | 1130.9 | 14.13 | | | |
| 12 | -619.3 | 10163.7 | 847.0 | 9.90 | | | |

[PgDn]:factored loads
F5 HELP [ENTER]: help

# Column Interaction Diagram




20 No 11

NON-FACTORED

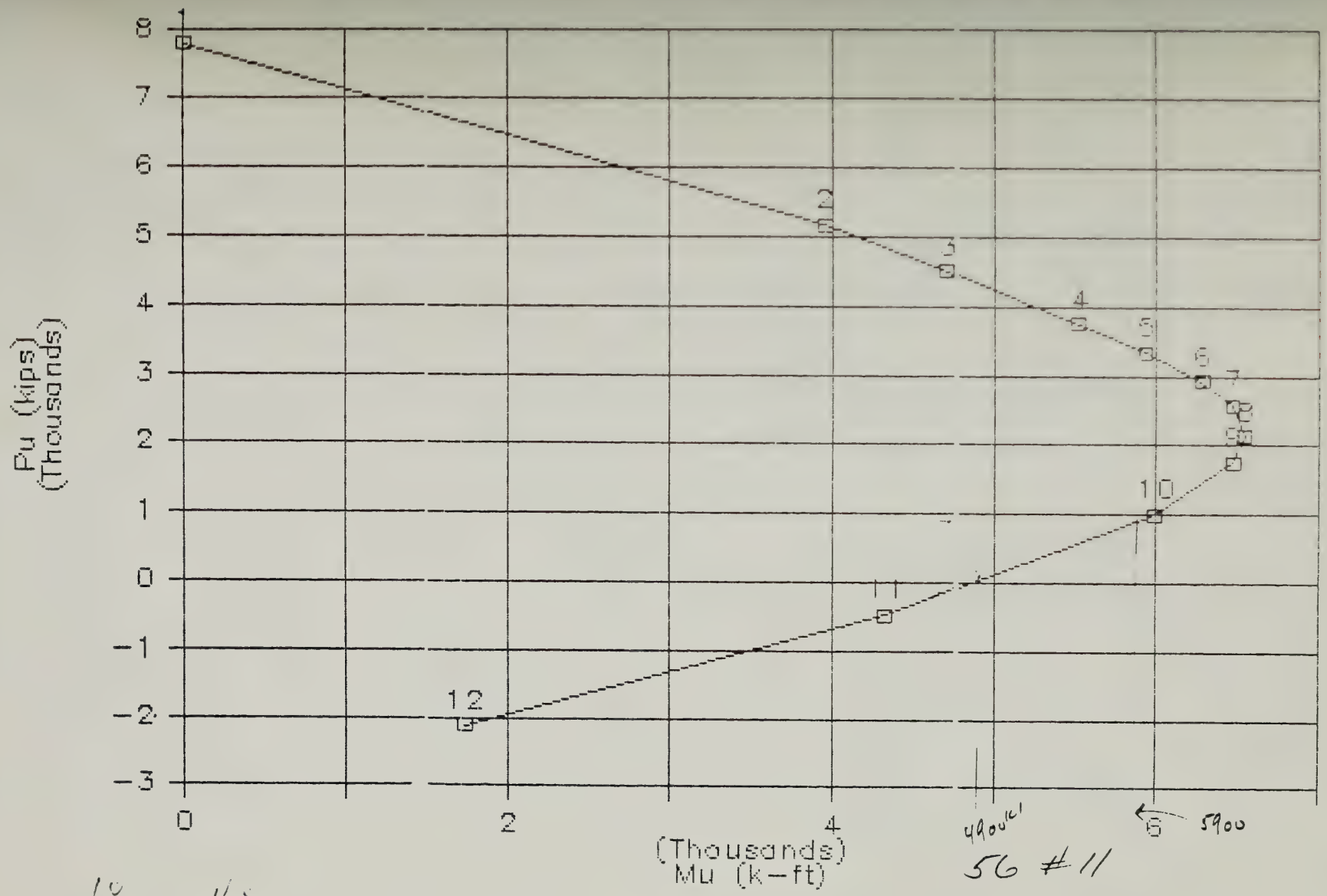
Es= ( 29000 ) h= ( 48 ) RECTCOL
fy= ( 40 ) b= ( 48 )
f'c= ( 2.5 ) B1= ( 0.85 ) COL: ( 20 # 11 )
nits : Psi Cb= ( 30.83 )

| point | Pu | Mu k-in | Mu k-ft | c | steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 6018.6 | 0.0 | 0.0 | | 1 | 3 | 7.42 |
| 2 | 4382.5 | 29670.4 | 2472.5 | 42.85 | 2 | 10 | 2.96 |
| 3 | 3976.9 | 34567.4 | 2880.6 | 39.41 | 3 | 17 | 2.96 |
| 4 | 3557.1 | 38818.8 | 3234.9 | 35.98 | 4 | 24 | 2.96 |
| 5 | 3334.3 | 40808.7 | 3400.7 | 34.26 | 5 | 31 | 2.96 |
| 6 | 3103.8 | 42699.3 | 3558.3 | 32.54 | 6 | 38 | 2.96 |
| 7 | 2867.6 | 44446.1 | 3703.8 | 30.83 | 7 | 45 | 7.42 |
| 8 | 2529.8 | 45222.9 | 3768.6 | 28.00 | 8 | 0 | 0 |
| 9 | 2052.5 | 45084.2 | 3757.0 | 24.00 | 9 | 0 | 0 |
| 10 | 1574.4 | 43293.8 | 3607.8 | 20.00 | 10 | 0 | 0 |
| 11 | 377.6 | 30915.3 | 2576.3 | 10.00 | | | |
| 12 | -1012.2 | 4014.2 | 334.5 | 2.00 | | | |

[PgDn]:factored loads
F5 HELP [ENTER]: help

NON FACTORED

# Column Interaction Diagram




56 #11

NON-FACTORED

44

45

56 # 11

| | | | |
|---|---|---|---|
| Es= ( | 29000 ) | h= ( | 48 ) |
| fy= ( | 40 ) | b= ( | 48 ) |
| f'c= ( | 2.5 ) | B1= ( | 0.85 ) |
| units : | ksi | Cb= ( | 28.21 ) |

56 REECTCOL

COL: ( # 11 )

| point | Pu | Mu k-in | Mu k-ft | c | steel level | di | area |
|---|---|---|---|---|---|---|---|
| 1 | 7810.9 | 0.0 | 0.0 | | 1 | 3 | 17.76 |
| 2 | 5172.7 | 47494.7 | 3957.9 | 42.06 | 2 | 6.82 | 8.88 |
| 3 | 4504.1 | 56685.0 | 4723.8 | 38.10 | 3 | 10.64 | 5.92 |
| 4 | 3750.8 | 66197.1 | 5516.4 | 34.15 | 4 | 14.45 | 2.96 |
| 5 | 3325.5 | 71180.3 | 5931.7 | 32.17 | 5 | 18.27 | 2.96 |
| 6 | 2919.3 | 75388.6 | 6282.4 | 30.19 | 6 | 29.73 | 2.96 |
| 7 | 2580.3 | 77627.8 | 6469.0 | 28.21 | 7 | 33.55 | 2.96 |
| 8 | 2126.9 | 78533.5 | 6544.5 | 25.00 | 8 | 37.36 | 5.92 |
| 9 | 1748.8 | 77674.6 | 6472.9 | 22.00 | 9 | 41.18 | 8.88 |
| 10 | 999.1 | 71863.3 | 5988.6 | 16.00 | 10 | 45 | 17.76 |
| 11 | -484.6 | 51961.2 | 4330.1 | 8.00 | | | |
| 12 | -2107.9 | 20829.2 | 1735.8 | 3.00 | | | |

[PgDn]:factored loads
F5 HELP [ENTER]: help

NON-FACTORED

RS/BLUME

3 Jessie Street (at New Montgomery)

Francisco, California 94105

SHEET NO. 1

NO. 8V73 JOB

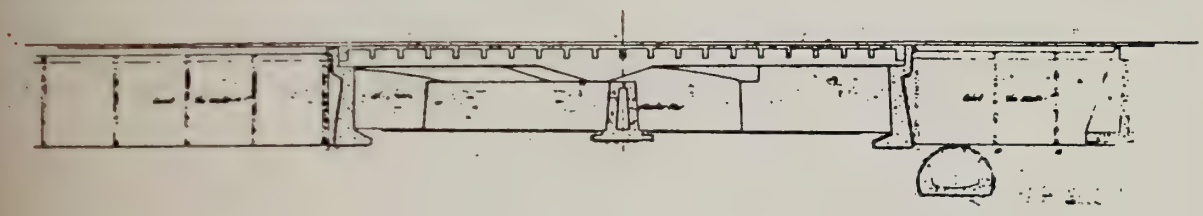
BY DATE

LNT SUBJECT MISSION ST. VIADUCT - @ ALEMANY

CHK'D DATE

SUPPORTING CALCULATIONS-

MISSION ST. VIADUCT AT ALEMANY.



SKEWED 2 SPAN CONTINUOUS R/C BRIDGE

S/BLUME
essie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. ii

NO. 6158 JOB S.F. BRIDGE SEISMIC EVALUATION BY DATE 1/4/84

T SUBJECT MISSION ST. & ALEMANY CHK'D DATE

# INDEX


| SUBJECT | SHEET |
|---|---|
| GIRDER SECTIONS | 1 |
| LOAD CALCULATIONS | 4 |
| ELASTIC PROPERTIES - BRIDGE DECK | 10 |
| ELASTIC PROPERTIES - PIER | 17 |
| SEISAB SIGN CONVENTION | 21 |
| BRIDGE GIRDER STRESS CHECK | 22 |
| CENTER PIER STRESS CHECK | 28 |
| STATIC CHECK ON FORCES | 37 |
| RESTRAINER DESIGN | 39 |

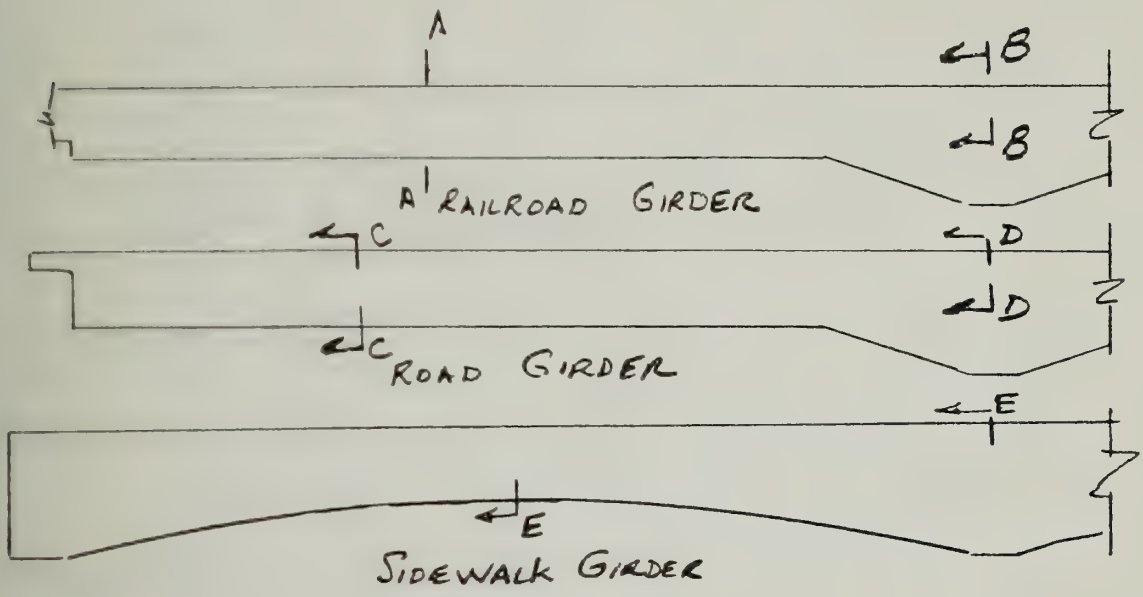
S/BLUME

Jessie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 1

NO. 8438 JOB BY STB DATE 6-14-84

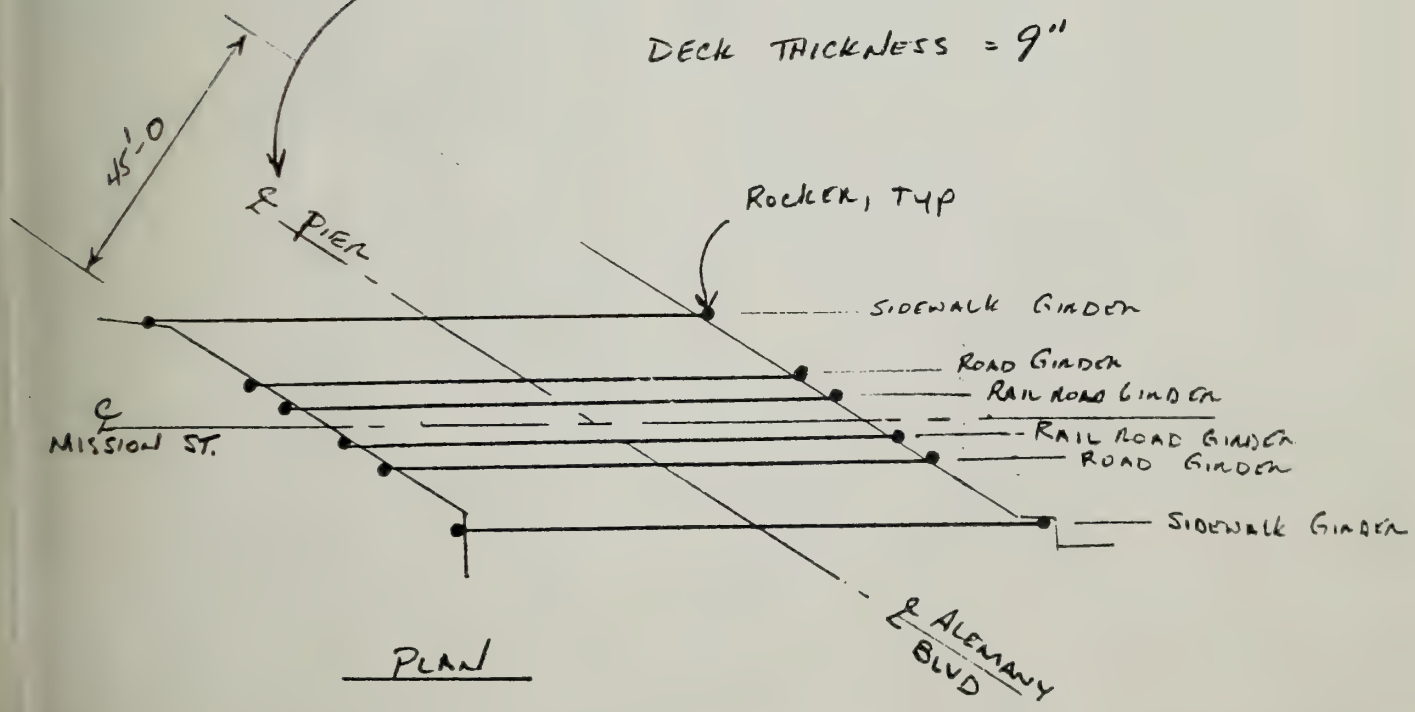
NT SUBJECT MISSION ST. VIADUCT - @ ALEMANY CHK'D GLM DATE 8/29/84




SEE DRAWING A-18679
FOR DETAILS OF REINF.

BEAMS N SYMMETRIC ABOUT ℄ PIER

DECK THICKNESS = 9"




PLAN

FS/BLUME
) essie Street (at New Montgomery)
n Francisco, California 94105

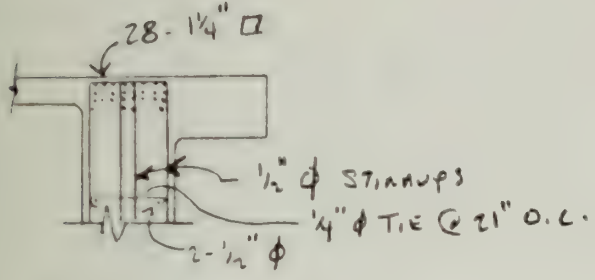
SHEET NO. 2

BNO. 2438 JOB

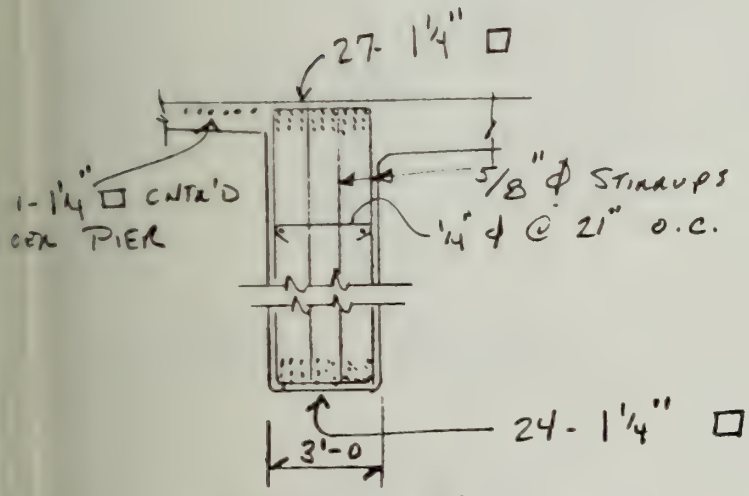
BY SRB DATE 6-14-84

ET SUBJECT MISSION ST. VIADUCT @ ALEMANY

CHK'D GLM DATE 9/24/..




SECTION D-D



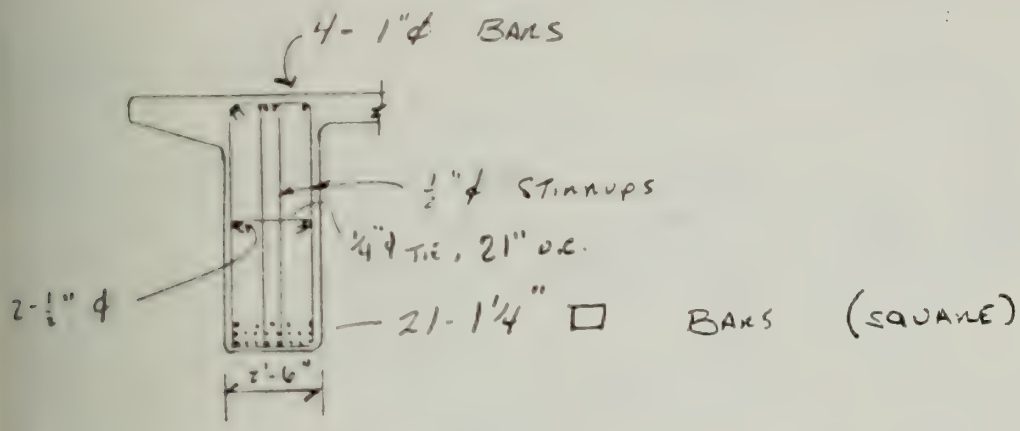

SECTION E-E

IFS/BLUME
0 essie Street (at New Montgomery)
an Francisco, California 94105

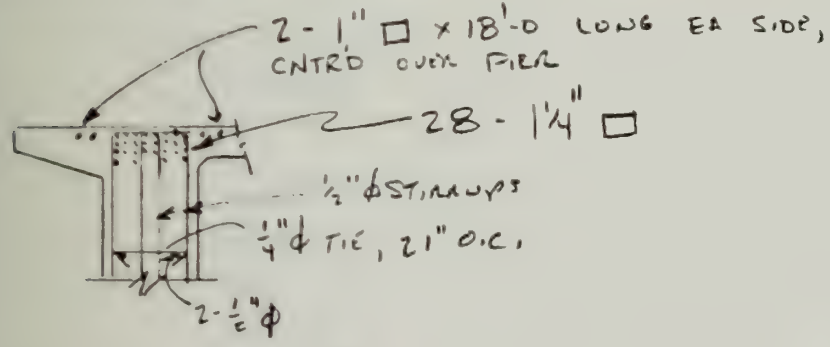
SHEET NO. 3

BNO. 8438 JOB BY STB DATE 6-14-84

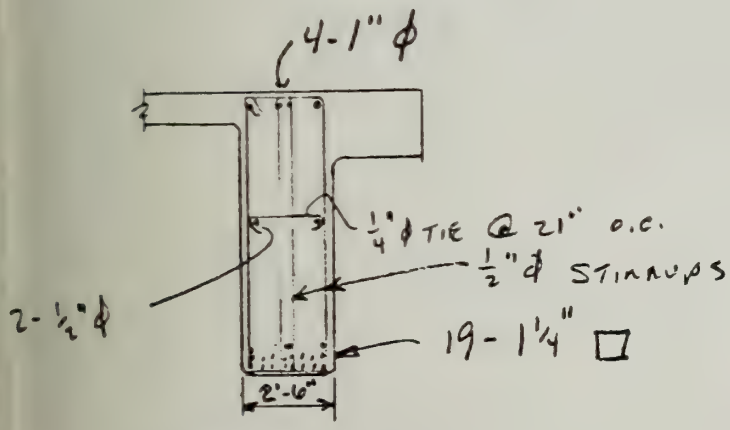
ET SUBJECT MISSION ST. VIADUCT - @ ALEMANY CHK'D GLM DATE 9/29/84




SECTION A-A



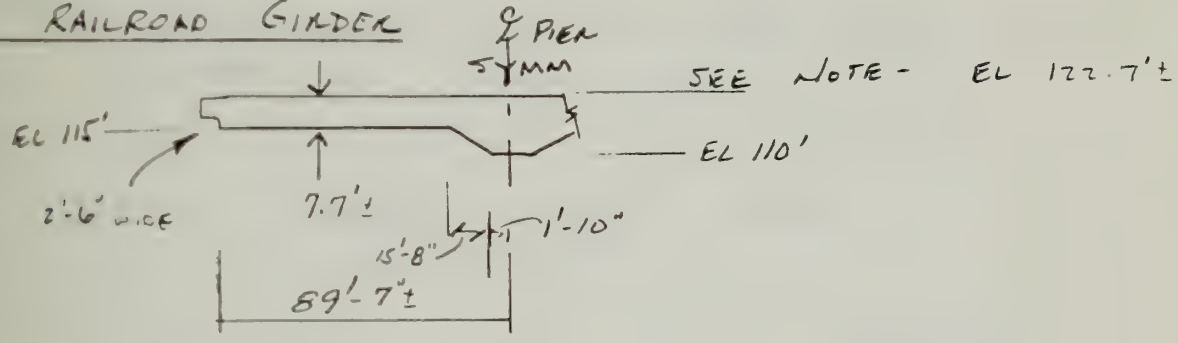

SECTION B-B




SECTION C-C

## DEAD LOADS

### RAILROAD GIRDER




NOTE - ELEVATION OF TOP VARIES DUE TO VERTICAL CURVE, USE AVG ELEV = 122.7' ±

STRAIGHT PORTION:

LENGTH = $(89'-7) - ((15'-8) + (1'-10)) = 72.08'$ (89.58', 17.5')

AREA = $(2'-6") \times 7.7' = 19.25\ FT^2$

WEIGHT = $0.15 \times 19.25 \times 72.08 = 208^K$

HAUNCHED PORTION

$19.25\ FT^2 \times 17.5' = 336.88\ FT^3$

$5' \times 15.67' \times 2.5' \times 1/2 = 97.94\ FT^3$

$1.83' \times 2.5' \times 5' = 22.92\ FT^3$

$457.74\ FT^3$

$\times 0.15 = 68.7^K$

$\Sigma\ 276.66^K$

FOR 1/2 GIRDER
i.e. - 1 SPAN

TOTAL = $276.66 \times 2 = \underline{\underline{553.^K}}$
(2 SPANS)
(1 GIRDER)

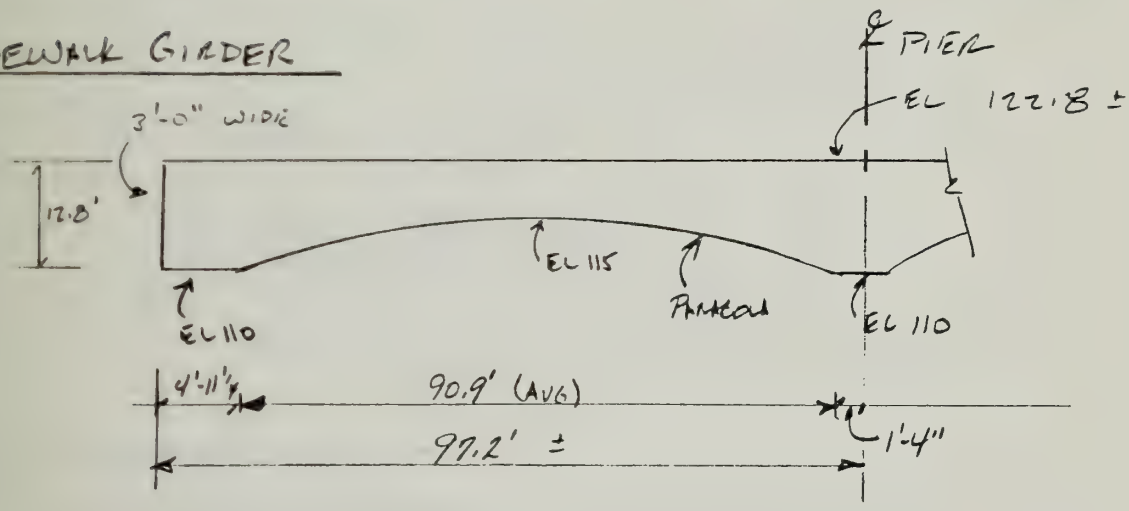
DEAD LOADS – CONT'D

ROAD GIRDER

GEOMETRically SAME AS RAILROAD GIRDER, SLIGHTLY DIFFERENT REINF, SLIGHTLY LIGHTER DUE TO CROWN & ROAD DECK, NEGLECT.

WEIGHT = 553$^K$ TOTAL
(2 SPANS)

SIDEWALK GIRDER




97.2' × 12.8' × 3' = 3732.5 FT$^3$
− 90.9' × 5' × 2/3 = − 303. FT$^3$ (PARABOLA)
3429.5 FT$^3$

× 0.15 = 514$^K$ N.W. & S.E. SPANS

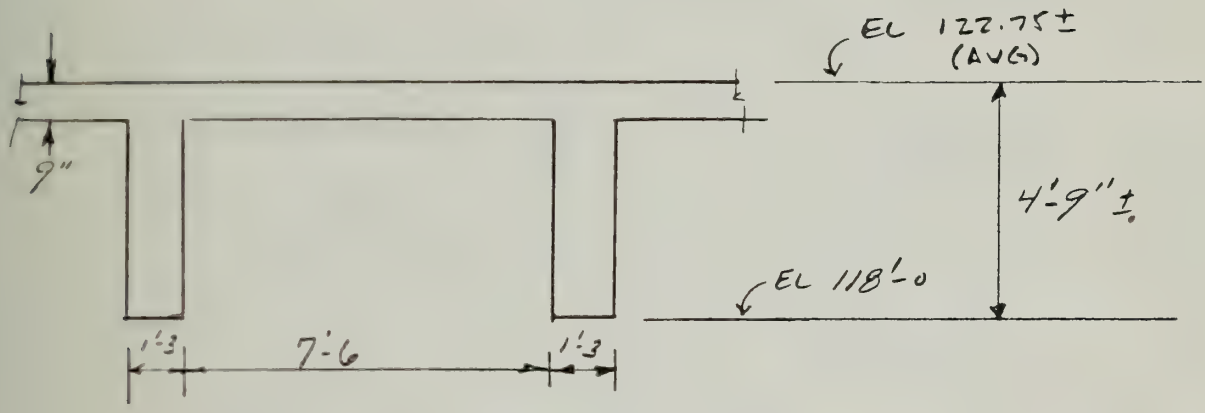
N.E & S.W. SPANS
86.24' AVG (VS 90.9')
92.51 ± (VS 97.2')
92.51 × 12.8' × 3' = 3552 FT$^3$
− 86.24 × 5 × 2/3 = − 287.5
3264.5 FT$^3$
× 0.15 = 490$^K$

916$^K$ EA GIRDER, 2 SPANS

TOTAL WT EA. SIDEWALK GIRDER (2 SPANS) = 1004$^K$

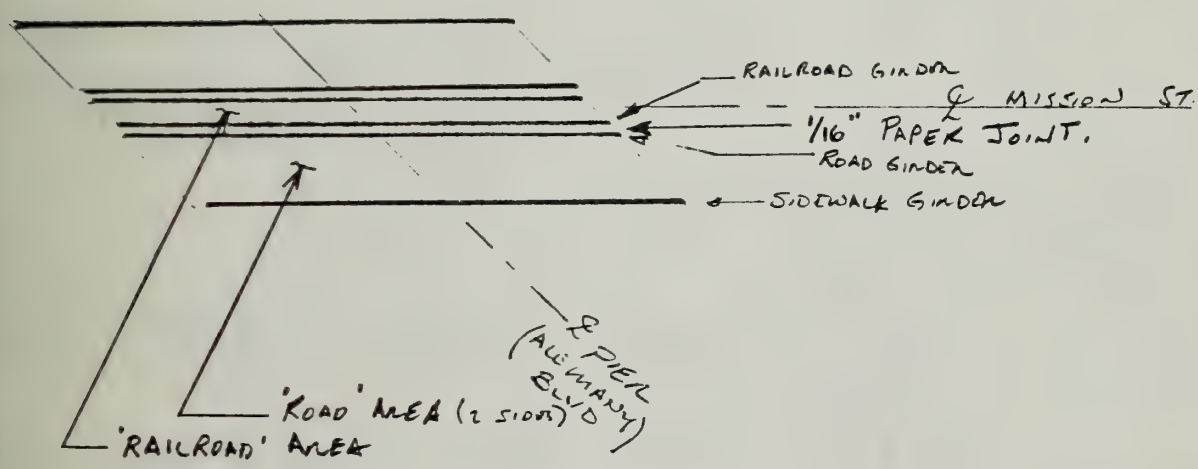
DEAD LOADS — CONT'D

CROSS BEAMS & SLABS:
(SOFFIT & CROSS BMS @ EL 116.00')




TYP CROSS BEAM SECT.

AREA OF TYP CROSS BM W/TRIB. SLAB:
$1.25' \times 4' + (1.75' + 7\tfrac{1}{2}') \times 9/12 = 11.56\ FT^2$




ROAD AREA: CLEAR SPAN (TYP) $= 18'-9 - \frac{3'-0}{2} - \frac{2'-6}{2} = 16'-0$

20 BEAMS × 2 SIDES × 16'-0 × 11.56 $FT^2$ × 0.15 $^K/FT^3$ = $\underline{1110^K}$* (555$^K$ PER ½ BRIDGE)

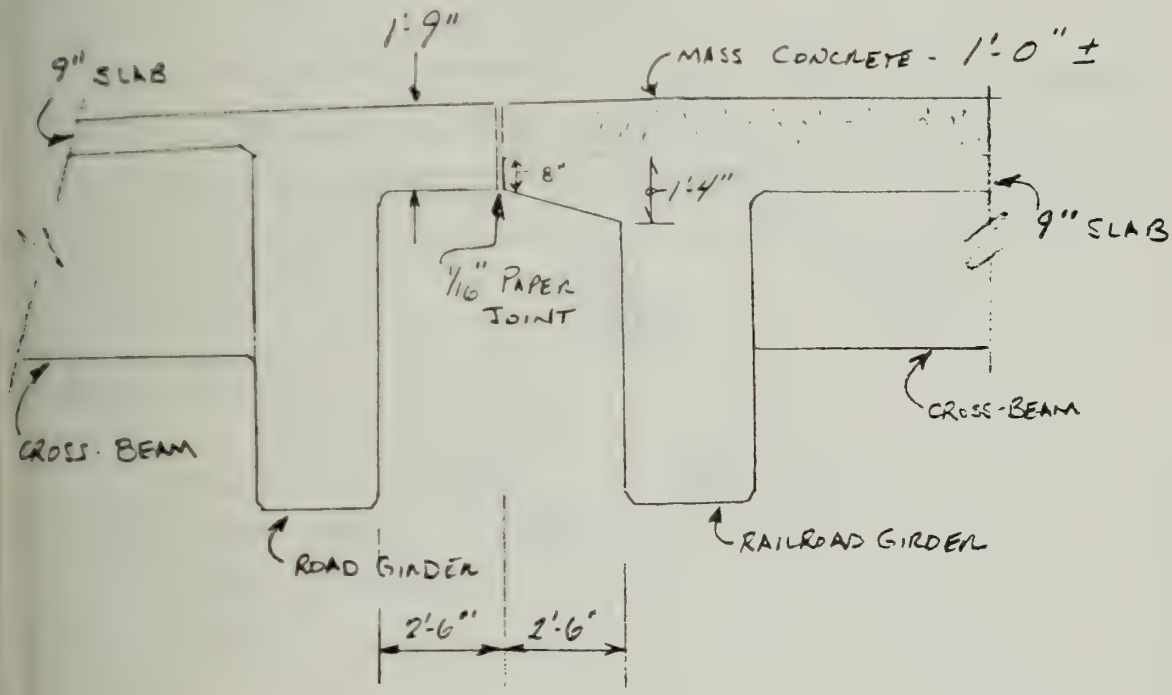
RAILROAD AREA: CLEAR SPAN = 10'-6 − 3'-0 = 7'-6"

20 BEAMS × 7'-6" × 11.56 $FT^2$ × 0.15 $^K/FT^3$ = $\underline{260^K}$ *

* CROSS BEAMS & 9" SLAB ONLY.

DEAD LOADS - CONT'D

REGION BETWEEN ROAD GIRDER & RAILROAD GIRDER:




ADDITIONAL WEIGHT TRIB TO RAILROAD GIRDERS:

MASS CONCRETE : $(5'-0 + 2'-6 + 2'-6)2 \times 1'-0 \times (89'-7'')\times 2 \times 0.15$ (179.17')

$= \underline{538^k}$ (TRIB TO BOTH GIRDERS)

HAUNCH $(8'' \times 2'-6 \times 179.17' + 8'' \times \frac{2'-6}{2} \times 179.17) \times 0.15 \times 2 = \underline{134.4^k}$

TOTAL TRIB TO BOTH GIRDERS

ADDITIONAL WEIGHT TO ROAD GIRDERS:

$2'-6'' \times 1'-9'' \times 179.17' \times 0.15^k/FT^3 = \underline{117.6^k}$ / EA GIRDER

ADDITIONAL WEIGHT TO SIDEWALK GIRDERS: (BALUSTRADE)

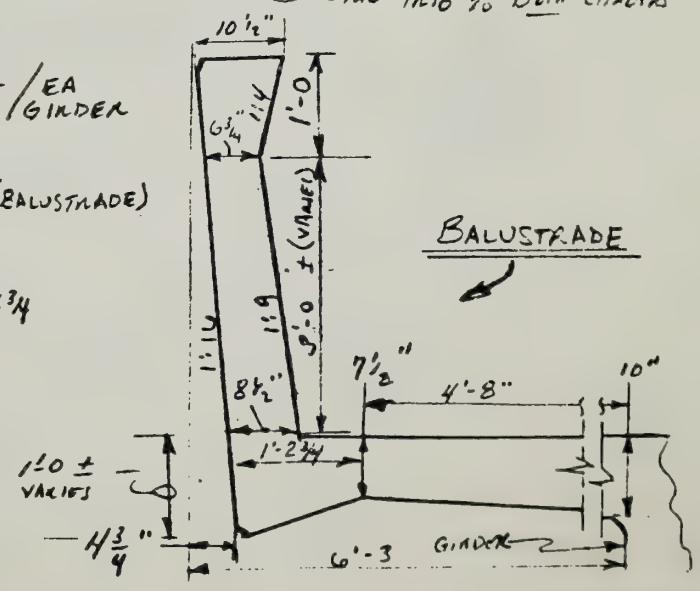
AREA of BALUSTRADE

$\frac{10\frac{1}{2}+6\frac{3}{4}}{2} \times 12'' + \frac{6\frac{3}{4}+8\frac{1}{2}}{2} \times 36'' + \frac{12+7\frac{1}{2}}{2} \times 14\frac{3}{4}$

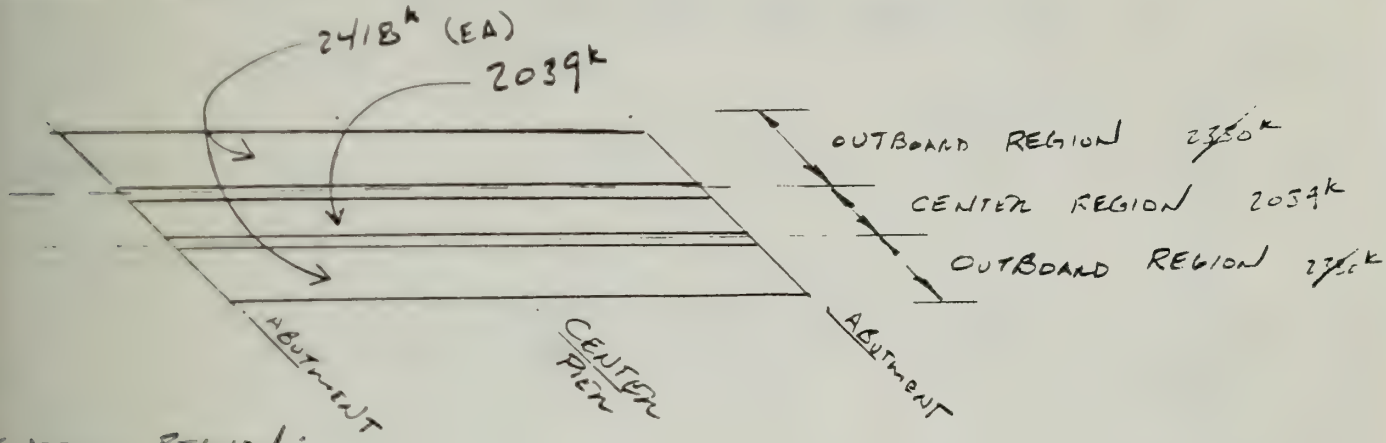
$+ \frac{7\frac{1}{2}+10}{2} \times 56'' = 1012.\ IN^2 = 7.03\ FT^2$

$\Rightarrow 1.05^k/LF$

$\times 179.17' = \underline{188.}$ KIPS PER SIDEWALK GIRDER.



DEAD LOAD OF DECK, SUMMARY:




CENTER REGION:

| | | |
|---|---|---|
| RAILROAD GIRDERS | 2@ 553k | 1106k |
| CROSS BEAMS & SLABS | | 260k |
| MASS CONCRETE | | 538k |
| HAUNCH | | 135k |
| | | 2039k |

OUTBOARD REGIONS (EACH):

| | |
|---|---|
| ROAD GIRDER | 553k |
| SIDEWALK GIRDER | 1004k |
| CROSS BEAMS & SLAB | 555k |
| CONC. BETWEEN ROAD GIRDER & R.R. GIRDER | 118k |
| BALUSTRADE | 188k |
| | 2418k |

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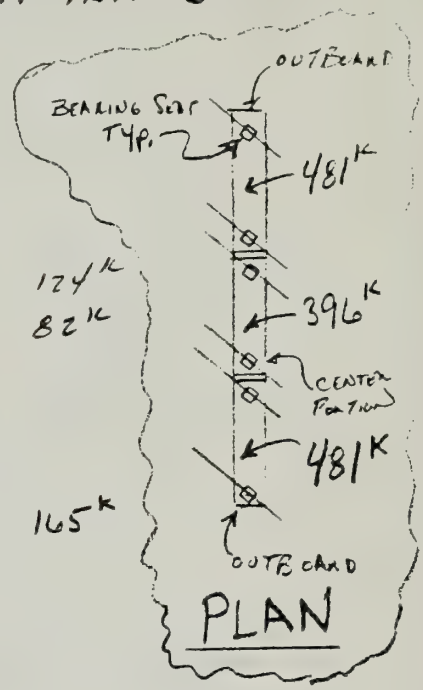
NO. 843B JOB BY STB DATE 6-18-84

SUBJECT MISSION ST. VIADUCT @ ALEMANY CHK'D DATE

DEAD LOAD OF PIER (CENTER PIER ONLY) REF DWG A-18 676

TWO JOINTS IN PIER SEPARATE THIS STRUCT. INTO 3 DISTINCT, ISOLATED PORTIONS.




OUTBOARD PORTIONS: 55'-1½" LONG

PILE CAP

1'-6" × 10'-0 × 55'-1½" × 0.15 K/FT³ = 124K

1'-6" × 6'-8" × 55.46' × 0.15 = 82K

ABOVE FDN LEVEL:

WALLS -

13½" × 17.82' × 55' × 0.15 = 165K

t_t  AVG HT.  (LONGER, W/ ALLOWAT of CURVED PORTION)

SOLID INTERIOR PORTION of PIERS:

12" × 16' × 2'-4½ × 4 × 0.15 = 23K

5'-0 × 16' × 2'-4½ × 2 × 0.15 = 57K

1.82' × 2'-0 × 55' × 0.15 = 30K

481K ← (EACH OUTBOARD PORTION)

CENTER PORTION: L = 18'-7½" × 2 = 37'-3

PILE CAP: 1'-6" × (10' + 6'-8) × 37'-3 × 0.15 = 140K

WALLS:

13½" × 15'-7½ × 17.82' × 2 × 0.15 = 94K

13½" × 6' × 7.82' × 0.15 = 53K

SOLID INTERIOR PORTION:

12" × 16' × 2'-4½ × 4 × 0.15 = 23K

1.82' × 2'-0 × 37'-3 × 0.15 = 20K

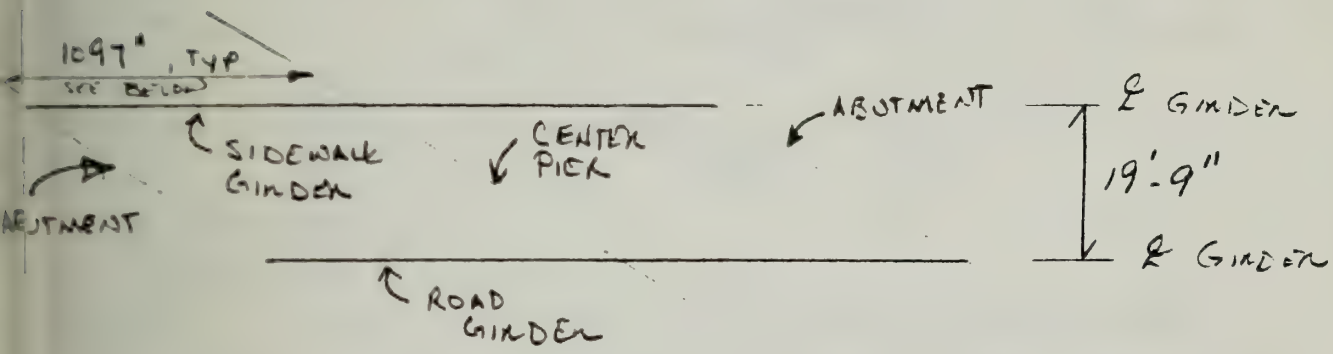
5' × 16' × 2'-4½ × 2 × 0.15 = 57K

12" × 6' × 10' × 0.15 = 9K

396K

ELASTIC PROPERTIES OF BRIDGE DECK

OUTBOARD REGIONS — SIDEWALK GIRDER + ROAD GIRDER + 9" SLAB

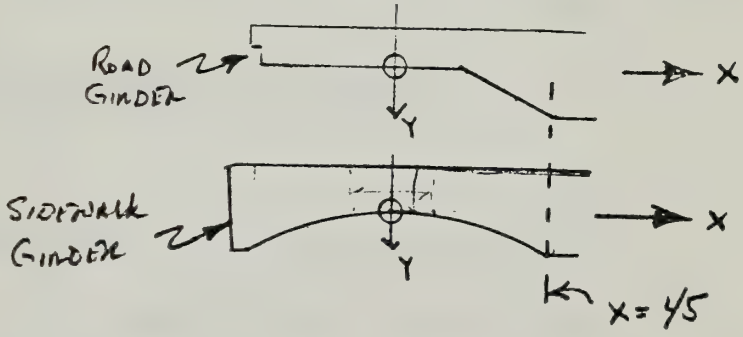



AVG SPAN OF SIDEWALK GIRDERS = 93.29'
AVG SPAN OF ROAD GIRDERS = 89.58'
USE AVG SPAN LENGTHS OF 91.44' = 1097"

PROFILE - SIDEWALK GIRDER VS/ROAD GIRDER

| X | Y S.W.G. | | Y ROAD G. | |
|---|---|---|---|---|
| | 0 | | 0 | |
| | 0.095 | 0.062 | 0 | |
| | .379 | 0.247 | 0 | |
| | .852 | 0.556 | 0 | |
| | 1.514 | 0.988 | 0 | |
| | 2.366 | 1.543 | 0 | |
| 27.5 | 2.863 | 2.125 | 0 | |
| 3 | 3.407 | 2.222 | ~~1.095~~ | 0.213 |
| 3 | 4.638 | 3.025 | ~~3.286~~ | 1.809 |
| 4 | ~~6.058~~ | 3.951 | ~~5.496~~ | 3.405 |
| 4 | ~~7.666'~~ | 5'-0 | ~~7.666'~~ | 5'-0 max |

← close enough




USE 3 SECTIONS FOR ANALYSIS

| | | | |
|---|---|---|---|
| (1) | x = 10' | VALID | x = 0, 17.5- |
| (2) | x = 25' | VALID | x = 17.5+, 32.5- |
| (3) | x = 40' | VALID | x = 32.5+, 45 |

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SHEET NO. 11

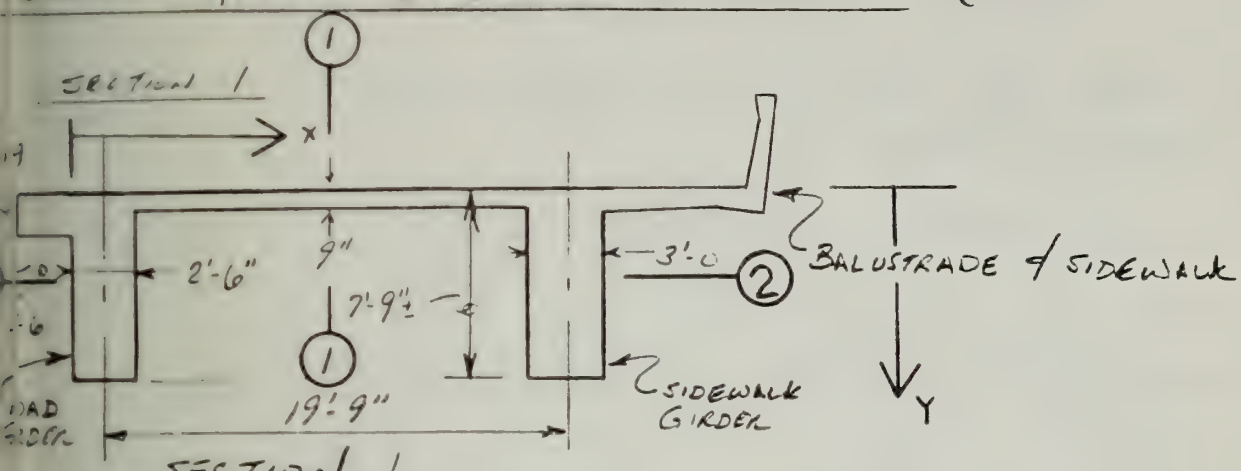
2 8438 JOB

BY STB DATE 6-84

SUBJECT MISSION ST. VIADUCT @ ALEMANY

CHK'D PEM DATE 9/6/84

ELASTIC PROPERTIES OF BRIDGE DECK, CONT'D (OUTBOARD REGION):




SECTION 1

SCALE - 1/8" = 1'-0

AMOUNT OF SECTION TO USE FOR STIFFNESS DETERMINATION: 7" SLAB + GIRDERS ONLY. OUTBOARD EXTENSIONS HAVE BEEN INCLUDED IN D.L. CALC'S.

$$\text{AREA} = 9'' \times \left(\underbrace{19'\text{-}9''}_{2430} + \underbrace{\frac{2'\text{-}6'' + 3'\text{-}0''}{2}}_{270''}\right) + \underbrace{7' \times (2'\text{-}6 + 3'\text{-}0)}_{2520 \quad 3024} = 7974 \text{ in}^2$$

$$\bar{x} = \frac{1}{7974}\left(2430 \times 270 \times 1/2 + 2520 \times \frac{30}{2} + 3024 \times (270 - 36/2)\right) = 141.45''$$

SAY 141.5"

$$\bar{Y} = \frac{1}{7974}\left(2430 \times \frac{9}{2} + (2520 + 3024) \times \left(\frac{84}{2} + 9\right)\right) = 36.83''$$

$I_{11}$: (VERTICAL AXIS) SLAB, d = 6.5" RG, d = 126.5" SWG, d = 110.5"

$$I_{11} = \underbrace{9 \times 270^3 \times 1/12}_{14.762 \times 10^6} + 2430 \times 6.5^2 + \underbrace{84'' \times 30^3 \times 1/12}_{189 \times 10^3} + 2520 \times 126.5^2 + \underbrace{84'' \times 36^3 \times 1/12}_{326.59 \times 10^3} + 3024 \times 110.5^2 = \underline{\underline{9.263 \times 10^7 \text{ in}^4}}$$

$I_{22}$: (HORIZ. AXIS) SLAB, d = 32.33", RG, d = 14.17 SWG, d = 14.17

$$I_{22} = \underbrace{270 \times 9^3 \times 1/12}_{16.403 \times 10^3} + 2430 \times 32.33^2 + \underbrace{30 \times 84^3 \times 1/12}_{1.4818 \times 10^6} + 2520 \times 14.17^2 + \underbrace{36 \times 84^3 \times 1/12}_{1.7781 \times 10^6} + 3024 \times 14.17^2 = \underline{\underline{6.929 \times 10^6 \text{ in}^4}}$$

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6438 JOB BY SOB DATE 6-84

SUBJECT MISSION ST VIADUCT @ ALEMANY CHK'D DATE

ELASTIC PROPERTIES of BRIDGE DECK - CONT'D (OUTBOARD REGION)

SECTION 2 SAME AS SECTION 1 w/ ROAD GIRDER DEPTH = 7'-9"
& SIDEWALK GIRDER DEPTH = 10'-1" ±

$$A = \underset{\text{SLAB}}{2430\ in^2} + \underset{\text{R.G.}}{2520} + \underset{\text{SWG.}}{\overset{4032}{112'' \times 36''}} = 8982\ in^2$$

$$\bar{x} = \frac{1}{8982}\left(2430 \times 270 \times \tfrac{1}{2} + 2520 \times 30/2 + 4032 \times (270 - 36/2)\right) = 153.85''$$

$$\bar{Y} = \frac{1}{8982}\left(2430 \times \tfrac{9}{2} + 2520\left(\tfrac{84}{2} + 9\right) + 4356\left(\tfrac{112}{2} + 9\right)\right) = 47.05''$$

say 47."

I: SLAB, d = 18.85" RG, d = 138.85" SWG, d = 98.15"

$$I_{11} = 14.762 \times 10^6 + 2430 \times 18.85^2 + 189.\times 10^3 + 2520 \times 138.85^2 + 112 \times 36^2 \times 1/12 + 4032 \times 98.15^2 = \underline{\underline{103.68 \times 10^6\ in^4}}$$

(X Axis) 100.4

I22: SLAB, d = 42.5" RG, d = 4." SWG, d = 18" - {REVISED #'S w/ CORRECTIONS MADE for GIRDER PROFILE - 51-0 MAX = Y}

(Y Axis)

$$I_{22} = 16.403 \times 10^3 + 2430 \times 42.5^2 + 1.4818 \times 10^6 + 2520 \times 4^2 + 36 \times 112^3 \times 1/12 + 4032 \times 18^2 = \underline{\underline{11.449 \times 10^6\ in^4}}$$

9.667

SECTION 3 SAME AS SECTION 1 w/ ROAD GIRDER DEPTH = 13'-3" ±
& SIDEWALK GIRDER DEPTH = 13'-10" ±

$$A = 2430 + \overset{4500}{150'' \times 30''} + \underset{5652}{157'' \times 36''} = 12582.\ in^2$$

$$\bar{x} = \frac{1}{12582}\left(2430 \times 270 \times \tfrac{1}{2} + 4500 \times 30/2 + 5652 \times (270 - 36/2)\right) = 144.64''$$

$$\bar{Y} = \frac{1}{12582}\left(2430 \times 9/2 + 4500 \times \left(\tfrac{150}{2} + 9\right) + 5652\left(\tfrac{157}{2} + 9\right)\right) = 70.22''$$

I: SLAB, d = 9.64" RG, d = 60.64" SWG, d = 57.14"

(X Axis)

$$I_{11} = 14.762 \times 10^6 + 2430 \times 9.64^2 + 150 \times 30^3 \times 1/12 + 4500 \times 60.64^2 + 157 \times 36^3 \times 1/12 + 5652 \times 57.14^2 = \underline{\underline{50.937 \times 10^6\ in^4}}$$

133.16

I2 SLAB, d = 61.22 RG, d = 13.78" SWG, d = 17.28"

(Y Axis)

$$I_{22} = 16.403 \times 10^3 + 2430 \times 61.22^2 + 150 \times 30^3 \times 1/12 + 4500 \times 13.78^2 + 157 \times 36^3 \times 1/12 + 5652 \times 17.28^2 = \underline{\underline{12.713 \times 10^6\ in^4}}$$

205.7

SECTION 4 @ X = -40' @ ABUTMENTS
SAME AS SECTION 1 W/ROAD GIRDER DEPTH = 7'-9'
& SIDEWALK GIRDER DEPTH = 11'-9"

$A = 2430 + 2520 + 4716 = 9666 \text{ IN}^2$

$\bar{X} = \frac{1}{9666}\left(2430 \times 270 \times 1/2 + 2520 \times \frac{30}{2} + 4716\left(270 - \frac{36}{2}\right)\right) = 160.80$

$\bar{Y} = \frac{1}{9666}\left(2430 \times 9/2 + 2520\left(\frac{96}{2} + 9\right) + 4716\left(\frac{131}{2} + 9\right)\right) = 50.79$

$I_{11}$ (VERT AXIS) : SLAB d = 25.8 RG d = 145.8 SWG, d = 91.20

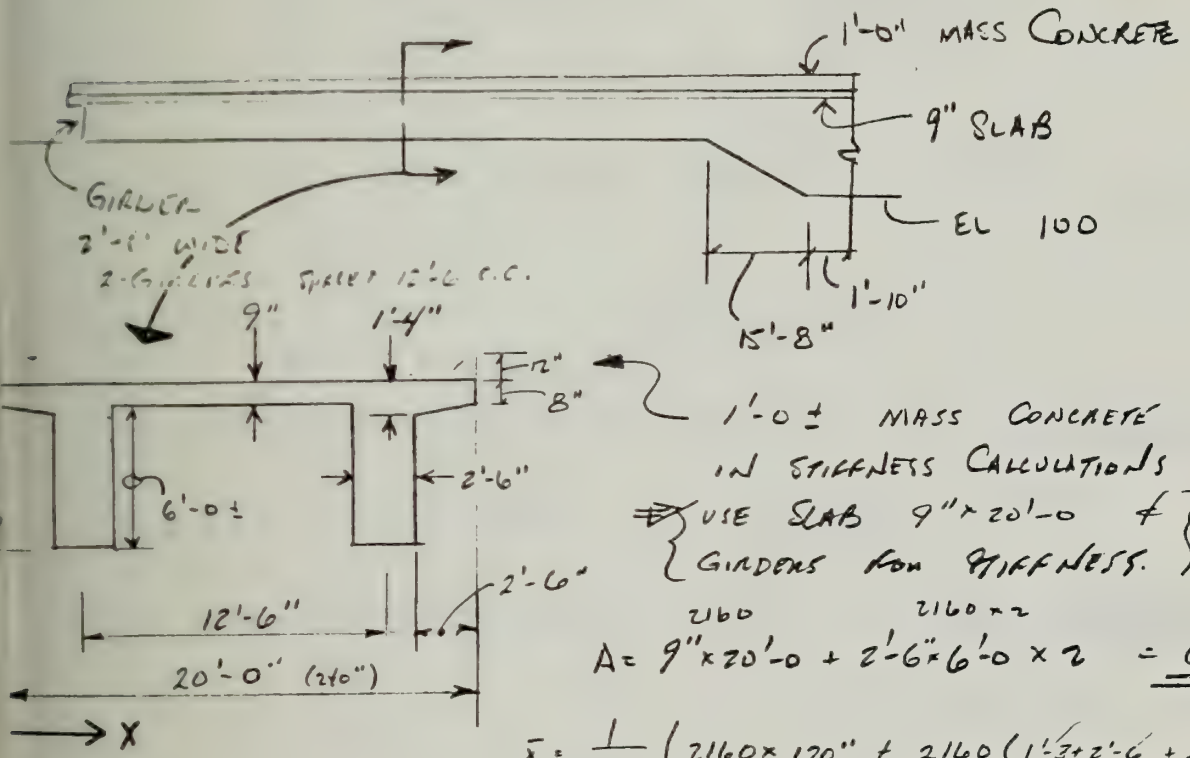
$I_{11} = 14.762 \times 10^6 + 2430 \times (25.8)^2 + 199 \times 10^3 + 2520(145.8)^2 + 131(36)^3 \frac{1}{12} + 4716(91.20)^2 = 1.099 \times 10^8 \text{ IN}^4$

$I_{22}$ (HOR'L AXIS) : SLAB d = 46.28 RG, d = 0.22 SWG, d = 23.72

$I_{22} = 16.403 \times 10^3 + 2430(46.28)^2 + 1.4818 \times 10^6 + 2520(0.22)^2 + (131)^3(36)\frac{1}{12} + 4716(23.72)^2 = 1.610 \times 10^7$

ELASTIC PROPERTIES OF BRIDGE DECK – CONT'D

CENTER REGION – (RAILROAD GIRDERS w/ 1'-0" MASS CONCRETE PLACED ON TOP OF 9" SLAB)




1'-0± MASS CONCRETE N.I.C. IN STIFFNESS CALCULATIONS

⇒ USE SLAB 9" × 20'-0 & GIRDERS FOR STIFFNESS.

$$A = \overset{2160}{9'' \times 20'-0} + \overset{2160 \times 2}{2'-6'' \times 6'-0 \times 2} = \underline{\underline{6480 \text{ in}^2}}$$

$$\bar{x} = \frac{1}{6480}\left(2160 \times 120'' + 2160\left(1'-3 + 2'-6 + 20'-0 - (2'-6) - (1'-3)\right)\right)$$

$$\bar{x} = 120'' \quad \leftarrow (@ \text{ CNTR SYMM})$$

$$\bar{Y} = 1/6480 \left(2160 \times 4.5 + 2 \times 2160\left(3'-0 + 9''\right)\right)$$

$$\bar{Y} = 31.5''$$

$I_{11}$: (VERT AXIS) SLAB, d = 0, GIRDERS, d = 75" (EA)

$$I_{11} = 9 \times 240^3 \times 1/12 + (72 \times 30^3 \times 1/12 + 2160 \times 75^2) \times 2 = \underline{\underline{34.992 \times 10^6 \text{ in}^4}}$$

$I_{22}$ (HORIZ AXIS) SLAB, d = 27" GIRDERS, d = 13.5" (EA)

$$I_{22} = 240 \times 9^3 \times 1/12 + 2160 \times 27^2 + (30 \times 72^3 \times 1/12 + 2160 \times 13.5^2) \times 2$$

$$\underline{\underline{I_{22} = 4.2428 \times 10^6 \text{ in}^4}}$$

ELASTIC PROPERTIES of LARGER DECK - CONT'D - (CENTER REGION) -

i SUPPORT — GIRDER DEPTH = 11' (132") ← (W/o SLAB)

$A = 2160 + \underset{3960 \times 2}{30'' \times 132'' \times 2} = \underline{\underline{10080.}}\ in^2$

$\bar{x} = \frac{1}{10080}\left(2160 \times 120 + \cdots\cdots\right) = 120''$ (symm)

$\bar{y} = \frac{1}{10080}\left(2160 \times 4.5 + 2 \times 3960 \times (66'' + 9'')\right) = 59.89''$ Say $\underline{60''}$

$I_{11}$ = (VERT AXIS) SLAB, d = 0 GIRDERS, d = 75" (EA)

$I_{11} = 9 \times 240^3 \times 1/12 + (132 \times 30^3 \times 1/12 + 3960 \times 75^2) \times 2 = \underline{\underline{55.512 \times 10^6\ in^4}}$

$I_{22}$ (HORIZ AXIS) SLAB, d = 55.5" GIRDERS, d = 15"

$I_{22} = 240 \times 9^3 \times 1/12 + (30 \times 132^3 \times 1/12 + 3960 \times 15^2) \times 2 = \underline{\underline{13.296 \times 10^6\ in^4}}$

$+ 2160(55\tfrac{1}{2})^2 = 19.95 \times 10^6$

ELASTIC PROPERTIES OF BRIDGE DECK, CENTER REGION (ONLY)
@ MID PT OF HAUNCH

GIRDER DEPTH = 9' (W/O SLAB)

$A = 2160 + 30'' \times 108'' \times 2 = 9640 \text{ in}^2$

$\bar{x} = 120''$ (SYMM)

$\bar{y} = \frac{1}{9640}\left(2160 \times 4.5 + 2 \times 3240 \times (54+9)\right) = 49.38''$

$I_{11}$ (VERT AX'S) : SLAB $d = 0$ GIRDERS, $d = 75''$

$I_{11} = 9 \times 240^3 \times \frac{1}{12} + \left(108 \times 30^3 \times \frac{1}{12} + 3240 \times (75)^2\right)(2) = 4.730 \times 10^7$

$I_{22}$ (HORIZ AX'S) : SLAB, $d = 43.88$ GIRDERS, $d = 14.62$

$I_{22} = 240(9)^3\left(\frac{1}{12}\right) + (2160)(43.88)^2 + \left[(30)(108)^3\frac{1}{12} + 3240(14.62)^2\right](2)$

$= 1.186 \times 10^7$

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SHEET NO. 17

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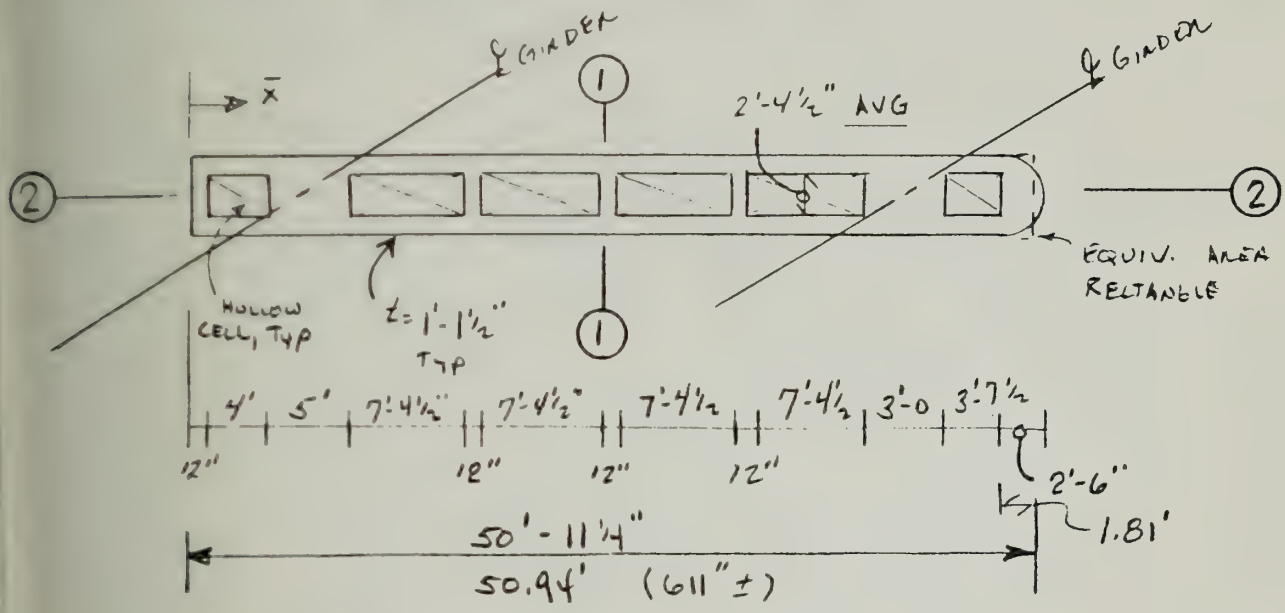
SUBJECT MISSION ST. VIADUCT @ ALEMANY CHK'D GLM DATE 9/4/84

ELASTIC PROPERTIES OF CENTER PIER - OUTBOARD REGION




16497. in²  4723 in²

AREA = 611" × (1'-1½ + 1'-1½) + 2'-4½ × (1' + 5' + 3' + 3' + 1.81')

13.81'  165.72"

AREA = 21220. in²

$$\bar{x} = \frac{1}{21220}\left(16497 \times \frac{611}{2} + 28\tfrac{1}{2}''\left(12'' \times 6'' + 60'' \times 90'' + 12'' \times 214.5'' + 12 \times 315'' + 12 \times 415.5 + 36'' \times 528'' + 21.72 \times 600.36''\right)\right)$$

$\bar{x}$ = 303.13"  SAY 303"

$$I_{11} = 27'' \times 611^3 \times 1/12 + 16497 \times 2.5^2 + 4 \times 28\tfrac{1}{2} \times 12^3 \times 1/12 + 342\,(297^2 + 88.5^2 + 12^2 + 112.5^2) + 28\tfrac{1}{2} \times 60^3 \times 1/12 + 1710\,(213^2) + 28.5 \times 36^3 \times 1/12 + 1026\,(225^2) + 28\tfrac{1}{2} \times 21.72^3 \times 1/12 + 619 \times 297^2$$

$$I_{11} = 735.34 \times 10^6 \text{ in}^4$$

$$I_{22} = 611 \times 13\tfrac{1}{2}^3 \times 1/12 \times 2 + 16497 \times 21^2 + 28\tfrac{1}{2}^3 \times (12'' + 60'' + 12'' + 12'' + 12'' + 36'' + 21.72'') \times \tfrac{1}{12} = 7.8454 \times 10^6$$

OUTBOARD REGION, CENTER PIER
TORSIONAL CONSTANT

$b = 49.94'$, $t_b = 1.125'$, $d = 3.5'$, $t_d = 1'$

$$K = \frac{2b^2d^2}{\frac{b}{t_b} + \frac{d}{t_d}} = \frac{2(49.94)^2(3.5)^2}{\frac{49.94}{1.125} + \frac{3.5}{1}} = 1275.9 \text{ ft}^4$$

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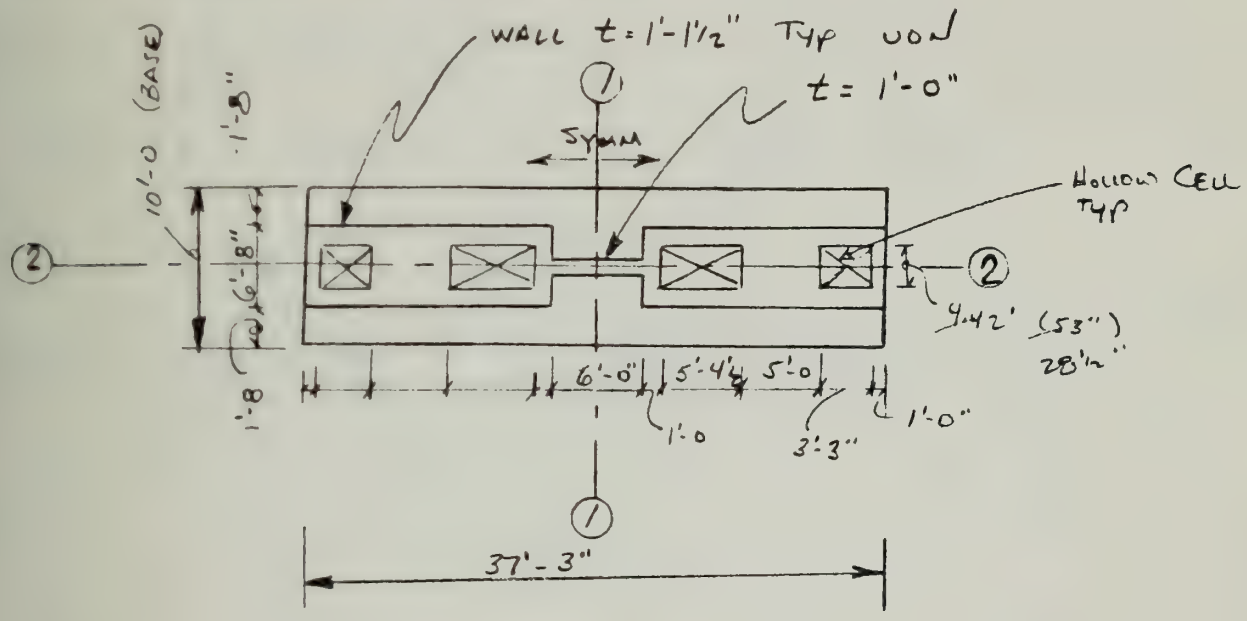
NO. 8438 JOB BY SPB DATE 6-84
T SUBJECT MISSION ST. VIADUCT @ ALEMANY CHK'D DATE

ELASTIC PROPERTIES OF CENTER PIER CONT'D - CENTER REGION




$$I_{11} = \left\{ \cancel{53}^{28\frac{1}{2}''} \times 12^3 \times 1/12 \times 2 + \cancel{53}^{28\frac{1}{2}''} \times 12\,(42^2 + 217.5^2) + \cancel{53}^{28\frac{1}{2}''} \times 60^3 \times 1/12 + \cancel{53}^{28\frac{1}{2}''} \times 60 \times 142.5^2 + 27. \times 187.5^3 \times 1/12 + 27. \times 187.5 \times 129.75^2 \right\} \times 2 + 12 \times 72^3 \times 1/12 = \cancel{394.}\ 305 \times 10^6 \text{ IN}^4$$

$$I_{22} = (187.5 \times 13.5^3 \times 1/12 + 13.5 \times 187.5 \times 33.25^2) \times 4 + 168 \times \cancel{53}^{28\frac{1}{2}''}{}^3 \times 1/12 + 72 \times 12^3 \times 1/12 = \cancel{35.4}\ 11.7 \times 10^6 \text{ IN}^4$$

$$A = 187.5 \times 13.5 \times 4 + 168 \times \cancel{53}\ 28.5 + 72 \times 12 = \cancel{19893.}\ 15777. \text{ IN}^2$$

ELASTIC PROPERTIES OF CENTER PIER CONT'D - CENTER REGION

TORSIONAL CONSTANT

IDEALIZE SECTION AS 2 CLOSED LOOPS

$t_d = 1.125'$, $t_b = 1.0'$, $b = 14.59'$, $d = 3.5'$

$$K = 2\left[\frac{2b^2d^2}{\frac{b}{t_b} + \frac{d}{t_d}}\right] = 4\left[\frac{(14.59)^2(3.5)^2}{\frac{14.59}{1.0} + \frac{3.5}{1.125}}\right] = 588.9 \text{ ft}^4$$

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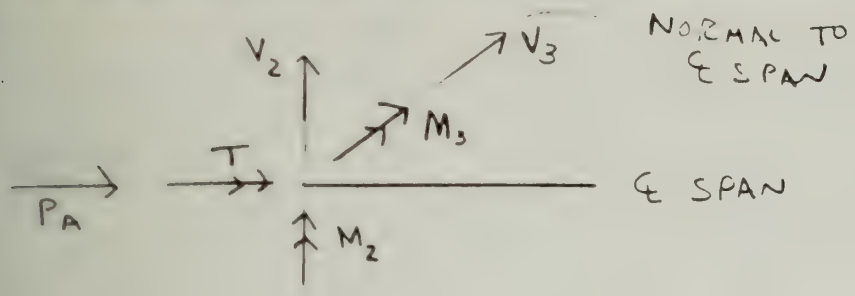
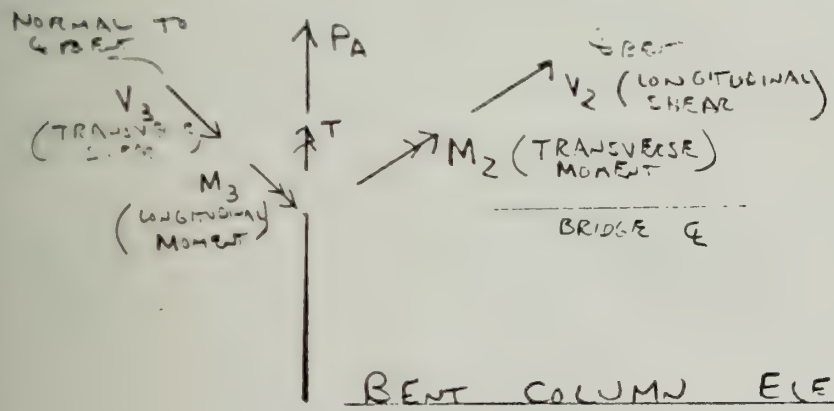
SHEET NO. 21

JOB S F BRIDGES BY GLM DATE 9/19/97

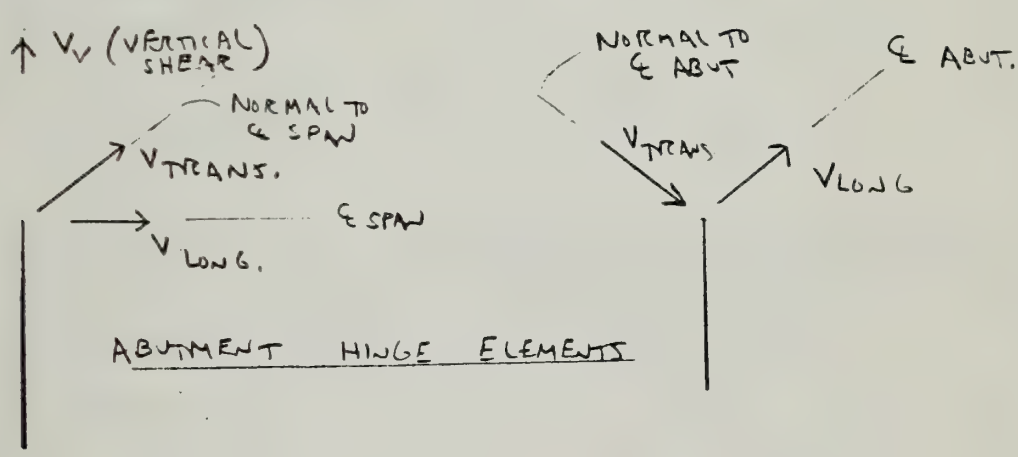
SUBJECT SEISAB RESULT INTERPRETATION CHK'D DATE




SPAN ELEMENTS




BENT COLUMN ELEMENTS




ABUTMENT HINGE ELEMENTS

W/R TO BRIDGE ℄

W/R TO ITEM ℄

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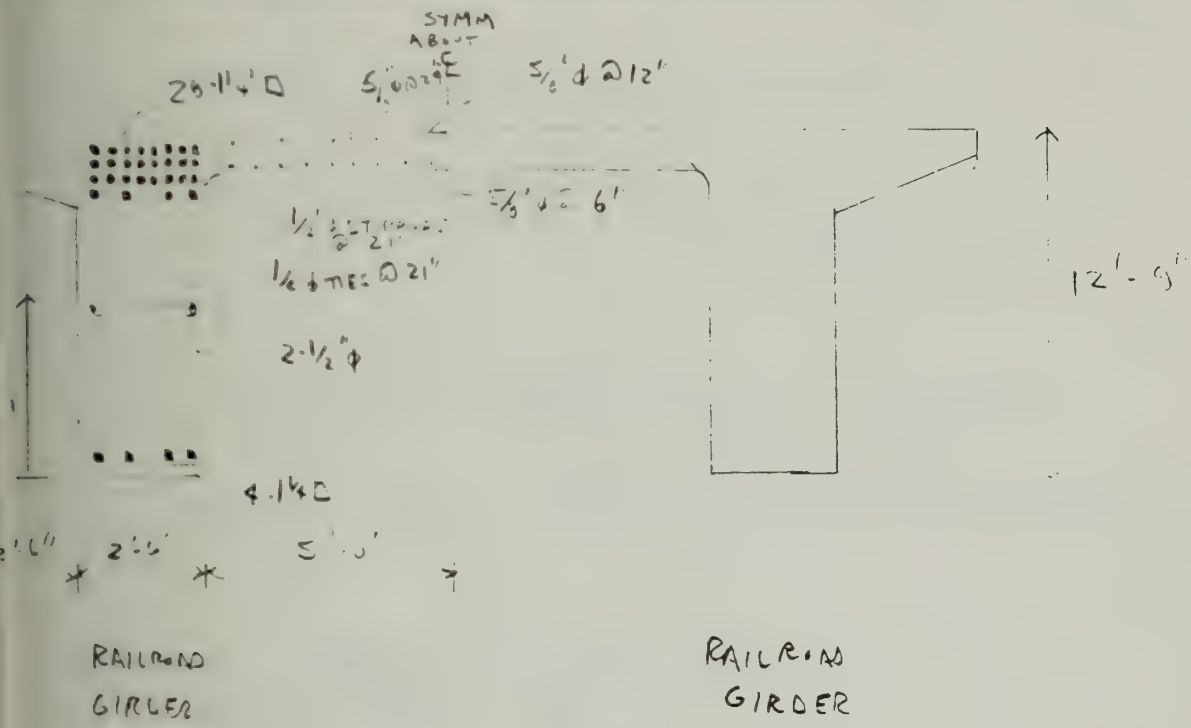
ncisco, California 94105

SHEET NO. 22

JOB SF BRIDGES BY GCM DATE 9/

SUBJECT MISSION ST. VIADUCT @ ALEMANY CHK'D DATE




AT CENTER PIER
CENTER REGION

PLASTIC CENTROID - FROM BOTTOM FIBER
ASSUME d = 144"

$$P.C. = \frac{\frac{(12.67)^2}{2}(2.5)(144)(2.5)(12) + (43.75\,in^2)(144) + (5.0)(3.5)(30\times..)}{(12.67)(2.5)(144)(2.5) + (43.75 + 5.0)(30)}$$

$$= 82.11''$$

CENTER REGION, BRIDGE GIRDER

$f'_c = 2500$ psi, $f_y = 30{,}000$ psi

BENDING ABOUT VERTICAL AXIS

$A_s = 21(1\tfrac{1}{4})^2 + 3.14 + 0.39 = 36.3 \text{ in}^2$

$b = 12.8'$

$d = 15 - 1.25 = 13.75'$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{36.3(30)}{.85(2.5)(12.8)(12)} = 3.34''$$

$$M_{u_2} = 0.9(36.3)(30)\left(13.75 - \frac{3.34 \div 12}{2}\right) = 13340 \text{ ft-k}$$

BENDING ABOUT HORIZ AXIS

$A_s = 2(28)(1\tfrac{1}{4})^2 = 87.5 \text{ in}^2$

$b = 2(2.5) = 5'$

$d = 12.67 - .67 = 12'$

$$a = \frac{A_s f_y}{.85 f'_c b} = \frac{87.5(30)}{.85(2.5)(5)(12)} = 20.59''$$

$$M_{u_3} = 0.9(87.5)(30)\left(12 - \frac{20.59 \div 12}{2}\right) = 26{,}323 \text{ ft-k}$$

AXIAL LOAD TENSION

$A_s = (2)[28(1\tfrac{1}{4})^2 + 4(1\tfrac{1}{4})^2 + 2(\pi)(.25)^2] = 100.8 \text{ in}^2$

$P'_o = 0.9(100.8)(30) = 2722^k$

AXIAL LOAD COMPRESSION

$A_g = (2)(2.5)(12.67)(2)(144) = 18244 \text{ in}^2$

$A_{st} = 100.8 \text{ in}^2$

$P = 0.8(0.7)[0.85(2.5)(18244 - 100.8) + 30(100.8)] = 23{,}284^k$

CENTER REGION, BRIDGE GIRDERS

$Z = 3.0$

AT CENTER PIER (SPAN ELEMENT 7)

$P_1 = \frac{1}{3.0}(1.0 \times 563 + 0.3 \times 432) = 231^k$
TRANSV. LONG

$M_2 = \frac{1}{3.0}(1.0 \times 9244 + 0.3 \times 7067) = 3788$ ft-k
TRANSV. LONG.

$M_3 = 15{,}371 + \frac{1}{3.0}(1.0 \times 5962 + 0.3(5309)) = 17889$ ft-k
DL TRANSV. LONG.

FOR COMPRESSION LOAD

$\frac{P_1}{P_c} = \frac{231}{23284} = 0.01 < 0.15$

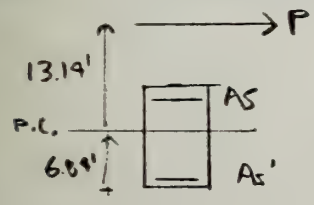
$\frac{M_2}{M_{u_2}} + \frac{M_3}{M_{u_3}} = \frac{3788}{13340} + \frac{17889}{26323} = 0.28 + 0.68 = 0.96 < 1.0$
O.K.

FOR TENSION LOAD

$e_2 = \frac{3788}{1361} = 2.79'$

$e_3 = \frac{17889}{1361} = 13.14'$

BENDING ABOUT HORIZ. AXIS
ASSUMING CONCRETE TAKES NO TENSION
TAKE MOMENTS ABOUT BOTTOM STEEL

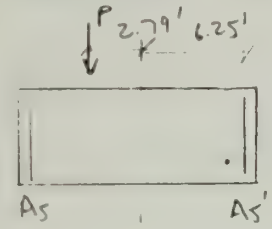



$P'_{3_0} = \frac{(87.5\ in^2)(30\ ksi)(144 - 3.5)(0.9) \div (12)}{6.84' + 13.14'}$

$P'_{3_0} = 1384.4^k$

CENTER REGION, BRIDGE GIRDERS, CONT.

BENDING ABOUT VERTICAL AXIS




ASSUMING CONCRETE TAKES NO TENSION & TAKING MOMENTS ABOUT $A_s'$,

$$P_{20}' = \frac{36.3\ in^2(30ksi)(12.5')(0.9)}{6.25' + 2.79'} = 1355.2^k$$

CHECKING FOR COMBINED LOAD

$$\frac{1}{P_u'} = \frac{1}{P_{20}'} + \frac{1}{P_{30}'} + \frac{1}{P_0'} = \frac{1}{P_u'} = \frac{1}{1355.2} + \frac{1}{1384.4} + \frac{1}{2722}$$

$P_u' = 547^k > 231^k$ SO. OK.

CENTER REGION, BRIDGE GIRDERS, CONT.

$V_{2\,VERT} = (\underset{TRANSV.}{209.7} + (0.3)\underset{LONG}{197.1}) + \underset{DL}{689.1} = 957.9^k$

$V_{3\,HORIZ} = [466.7 + 0.3(356.6)] + 0 = 573.7^k$

$T = [2.94 + 0.3(2.99)] + 4.90 = 8.6$ ft·k

CHECK TORSIONAL STRENGTH OF CONCRETE

$T_c = \phi(0.5\sqrt{f'_c}\,\Sigma x^2 y)$

$= 0.85(0.5\sqrt{2500}[(2)(30)^2(152) + (9)^2(120)])$

$= 233$ ft-k $> 8.6$ SO TORSION NEED NOT BE COMBINED WITH SHEAR

$V_2$ SHEAR RESISTANCE PROVIDED BY STIRRUPS (8-½" ⌀ @21")

$V_s = \frac{A_v f_y d}{s} = \frac{8(0.2\,in^2)(30\,ksi)(144'')}{21''} = 329^k$

CONCRETE SHEAR RESISTANCE

$V_c = (1.9\sqrt{f'_c} + 2500\,\rho_w \frac{V_u d}{M_u})\,b_w d$

$= 2(1.9\sqrt{2500} + 2500(\frac{87.5}{144(60)})(\frac{957.9(144)}{17989(12)}))(30)(144)$

$= 820.8 + 140.6 = 961.4^k$

$V_{c\,MAX} = 3.5\sqrt{2500}(60)(144) = 1512^k > 961.4$ SO, $V_c = 961.4^k$

$V'_n = 0.85(329 + 961.4) = 1097^k > 957.9$ O.K.

CENTER REGION, BRIDGE GIRDERS CONTD

DEFLECTIONS $\frac{L}{240} = \frac{91.4(12)}{240} = 4.57''$

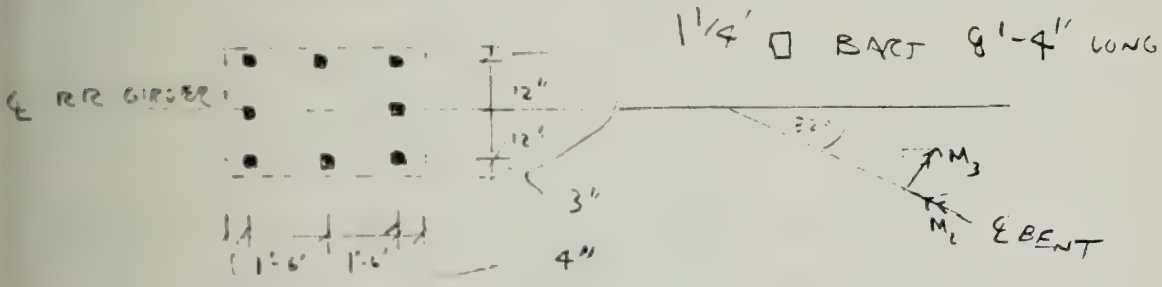
$\Delta_{TRANSV}$ (NODE 6) $= \underset{TRANS}{.0075} + \underset{LONG}{.0077(0.3)} + \underset{DL}{0} = 0.12'' < 4.57$ O.K.

$\Delta_{LONG}$ (NODE 2) $= \underset{TRANSV.}{.0065} + \underset{LONG}{.0053(0.2)} + \underset{DL}{0} = 0.16'' < 6''$ O.K.

$\Delta_{VERT}$ (NODE 4) $= \underset{TRANSV.}{.0182} + \underset{LONG.}{.0179(0.3)} + \underset{DL}{.035} = 4.48'' < 4.57$ O.K.

CENTER PIER, CENTER PORTION

DOWELS CONNECTING PIER TO RAILROAD GIRDERS




BENT COLUMN ELEMENT 4 NODE 3 IS AT TOP OF PIER

$M_{2\,TRANSV.} = 6315_{TRANS} + 0.3(5622)_{LONG} + 0_{DL} = 8002$ k-ft

$M_{3\,LONG.}' = 10{,}114 + 0.3(9005) + 0_{DL} = 12{,}816$ k-ft

$V_{LONG} = 763 + 0.3(584) + 0 = 940^k$

$V_{TRANS.} = 1442 + 0.3(1101) + 0 = 1772^k$

$P = 1378^k_{DL} - 4.5'(109.6\,ft^2)(0.2\,kcf) = 1279^k$ COMP
↑ COLUMN WT OF ELEMENT

← 2 GIRDERS

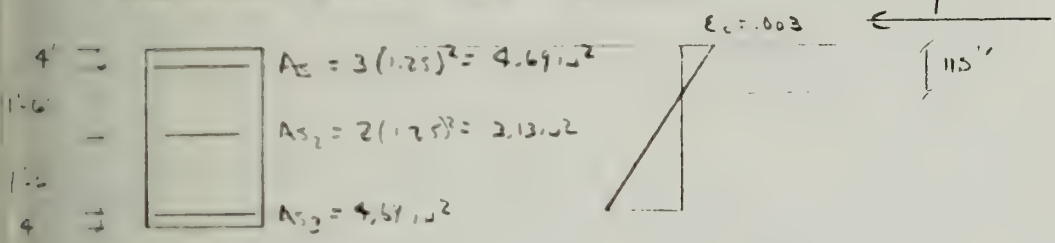
$P_0 = (2)0.85\left[(2.5)\left[(42")(30") - 8(1.25)^2\right] + 30(8)(1.25)^2\right] = 5939^k$

$M_{2\,(ABOUT\ ℄\ RRG)}' = \cos 32°(8002) + \sin 32°(12816) = 6786 - 6791 \approx 0$

$M_{3\,(ALONG\ RRG)}' = \sin 32°(8002) + \cos 32°(12816) = 4240 + 10869 = 15109$

DOWELS

BENDING ALONG RR GIRDER




$P = 1279^k$ $\quad P_{PER\ GIRDER} = \frac{1279}{2} = 639.5$

ASSUME ALL STEEL YIELDS

$T = C$

$639.5 + 4.69(30\ ksi) + 3.13(30\ ksi) = 4.69(30\ ksi) + (0.85)^2 c\,(30")(2.5\ ksi)$

$C = (639.5 + 140.7 + 93.9 - 140.7) \div 54.19$

$C = 13.5"$ , $a = .85\,c = 11.5"$

$\Sigma M_c = 0$ (PER GIRDER)

$M_3 = 140.7(1.5') - 140.7(1.5') + 54.19(13.5)\left(1.83 - \frac{11.5}{2(12)}\right) = 988\ ft\text{-}k$

$0.2 f'_c A_g = 0.2(2.5)(30)(42) = 630^k$

$P_a = 639.5 > 630$ SO $\phi = 0.5$

$M_3' = 0.5(988) = 494\ ft\text{-}k \not> \frac{15109}{2\,(1)} = 7555\ ft\text{-}k$ NO GOOD

2 GIRDERS 2 FACTOR

MUST BE REDESIGNED

CHECK SHEAR

MUST BE CARRIED BY SHEAR FRICTION

$V_{MAX} = \sqrt{(940)^2 + (1772)^2} = 2006^k$

SHEAR FRICTION

$V_n = (0.6)[(2)(4.69)(30\ ksi) + 1279] = 936 \not> 2006$

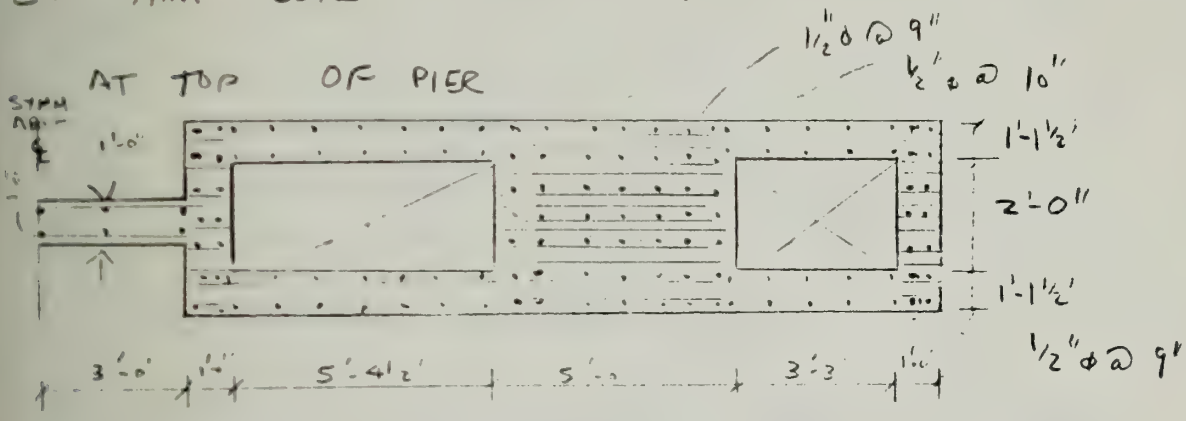
NO GOOD

$R_{ATIO} = \frac{2006}{936} = 2.14$

CENTER PIER, CENTER PORTION

ASSUME DECK PIER INTERFACE CAN BE REPAIRED SO THAT LOAD ENTERS PIER.

AT TOP OF PIER



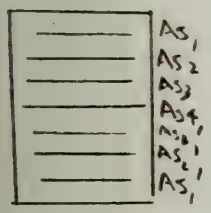

AXIAL LOADS

$0.2 f'_c A_g = 0.2(2.5\,ksi)(1577\,in^2) = 788^k$

$\phi = 0.5$ FOR $0.2 f'_c A_g$ + 0.9 FOR $0 \times f'_c \times A_g$

$\phi = 0.9 - 0.4\left(\frac{1279}{7888}\right) = 0.84$

BENDING ABOUT LONGITUDINAL AXIS




$A_{s_1} = A_{s_2} = 2(0.2)\left[\frac{1+1+5}{9/12} + \frac{5.375+3.25}{10/12}\right] = 3.74 + 4.14 = 7.88$

$A_{s_3} = A_{s_4} = 3.74$

ASSUME ALL STEEL EXCEPT LAST ROW HAS YIELDED

0 ROWS IN COMPRESSION

$C = T$, $(.85)(2.5)(31.25')(12)(c) = 1279 + [3.74(3) + 7.88(3)](30)$ 34 ok

$677.3\,c = 2324.8$, $c = 3.43''$

$M'_{n_2} = 0.84\left(677.3(3.43)\left(25.5 - \frac{(.85)(3.43)}{2}\right) + (30)(3.86)\left(25.5 - \left(\frac{51.34}{2}\right)\right)\right)$

$= .84(55857 + 1778) = 4034$ ft-k

$M_2 = \frac{Bow_2}{2} = 4001$ ft-k $< 4034$ o.k.

CENTER PIER, CENTER PORTION
TOP OF PIER
BENDING ABOUT TRANSVERSE AXIS

ASSUME ALL STEEL YIELDS

$$a = \frac{1282.2 + 1279}{.85(2.5)(51)} = 23.6''$$

SO NOT ALL STEEL YIELDS
ASSUME ALL BUT LAST 3 ROWS YIELD

$$A_s = 42.74 - 3(7)(.2) = 39.54$$

$$.85(2.5)(51'')a + 1.4(30) = 39.54(30) + 1279$$

$$108.4\,a = 1156.2 + 1279 - 42$$

$$a = 22.1'', \quad c = \frac{a}{.85} = 25.97'' > 12''$$ MUST USE TRIAL

ASSUME 4 ROWS STEEL NOT IN TENSION, $A_s = 42.74 - 4(7)(.2) = 37.14$

$$(.85)(2.5)(51)(12) + (.85)(2.5)(27)(x) + 3(7)(.2)(30) = 37.14(30) + 1279$$

$$x = (1114.2 + 1279 - 1301 - 126) \div 57.375 = 37''$$

$$M'_u = 0.84\left[1301\left(\frac{37.25}{2} - \frac{0.85(12)}{12(.12)}\right) + (57.375)(17)\left(\frac{37.25}{2} - 1 - \frac{0.85(17)}{2(12)}\right) + 126\left(\frac{37.25}{2} - \frac{12}{2}\right) + 1114\left(\frac{37.25}{2}\right.\right.$$

$$= .84[23{,}679 + 16{,}604 + 2221 + 1360] = 36{,}843 \text{ ft-k}$$

$$\frac{M_2}{M'_{u2}} + \frac{M_3}{M'_{u3}} = \frac{4001}{4034} + \frac{6409}{36843} = 0.99 + 0.17 = 1.16$$

$$V_c = .85\left(2\sqrt{2500}\right)(15777) = 1341^k$$

$$V_{s\,\text{LONG}} = \frac{0.85(0.2\ \text{in}^2)(0.8)(187.5'')(30\ \text{ksi})}{18''}(4)(2) = 340^k$$

(2 ; 4 = END LEGS)

$$V_{s\,\text{TRANS}} = \frac{0.85(0.2\ \text{in}^2)(0.8)(24'')(30\ \text{ksi})}{18''}(6)(2) = 65^k$$

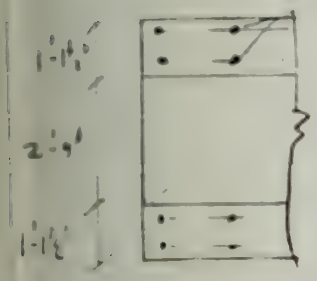
$$V_{N\,\text{TRANS}} = 1341 + 65 = 1406 \not> 1772$$ NO GOOD PLASTIC HINGE

CHECK IN USING COLUMN

$$V_{N\,\text{LONG}} = 1341 + 340 = 1681^k > 940^k$$ O.K.

CENTER PIER, CENTER PORTION

PIER BOTTOM CONNECTION




#7 ϕ DOWELS @ 18"

$b = 2(15'-7\tfrac{1}{2}") = 31.25'$

$A_s$ (PER LINE) $= \dfrac{(0.21\,in^2)(31.25')}{(1.5')} = 4.2\ in^2$

(ACTUAL PIER CONFIGURATION IS THE SAME AS TOP OF PIER EXCEPT THE OPENING IS 2'-9" RATHER THAN 2'-0". THE CONNECTION FOR FOOTING TO PIER IS SAME)

$P_{LL} = 1772.7^k$

$V_{2(LONG)} = 946.3^k$

$V_{3(TRANS)} = 1984^k$

$M_{2(TRANS)} = 29{,}089$ ft-k

$M_{3(LONG)} = 20{,}399$ ft-k

$P = 1773 < 0.25 f'_c A_g = 7888$

$\phi = 0.9 - 0.4\left(\frac{1773}{7888}\right) = 0.81$

PIER BOTTOM

BENDING ABOUT LONG. AXIS

$c = \dfrac{A_s f_y + P}{(0.85 f'_c)(b)} = \dfrac{34.86(30) + 1773}{677.3} = 4.16",\ a = 3.54"$

$M = 0.81\left[(677.3)(4.16)\left(30 - \frac{3.54}{2}\right) + 34.86(30)\left(\frac{30}{2} - \frac{30-3.54}{2}\right)\right]$

$= 0.81[79{,}540 + 1851] = 5494$ ft-k $\not> 29{,}089 \div 2 = 14545$

SO NO GOOD

BENDING ABOUT TRANS. AXIS

ASSUME ALL BUT LAST 3 ROWS YIELD.

CENTER PIER / CENTER PORTION
AT BOTTOM OF PIER - SECTION SAME AS TOP
EXCEPT HOLE IS 2'-9" RATHER THAN 2'-0"
FROM TOP CALC: $A_s = 37.14 in^2$

$$(.85)(25)(x)(12) + (.85)(2.5)(27)(x) + 3(7)(.2)(30) = 37.14(30) + 1773$$
$$x = (1114.2 + 1773 - 1530 - 126) \div 57.375 = 21.5''$$

$$M_u' = 0.81\left[1530\left(\frac{37.25}{2} - \frac{0.85(12)}{2(12)}\right) + 57.375(21.5)\left(\frac{37.25}{2} - 1 - \frac{.85(21.5)}{2(12)}\right) + 126\left(\frac{37.25}{2} - \frac{12}{12}\right) + 1114\left(\frac{33.5}{2(12)}\right)\right]$$
$$= 0.81[27,946 + 20,902 + 2221 + 1555] = 42,463 \text{ ft-k}$$

$$M_3 = -\frac{20,349}{2} = 10175$$

$$\frac{M_2}{M_1'} + \frac{M_3}{M_3'} = -\frac{14545}{5494} + -\frac{10175}{42463} = 2.65 + 0.24 = 2.89$$

SHEAR

$V_{N\,TRANS} = 1406 \quad > 1394$

$V_{N\,LONG} = 1681 \quad > 946$

PIER BOTTOM CONNECTION
BENDING ABOUT LONG. AXIS

$$c = \frac{4.2(3)(30) + 1773}{.85)^2(2.5)(31.25)(12)} = 2.6'' \qquad a = 2.2$$

$$M_2 = 0.91\left[677.3(2.6)\left(30 - \frac{2.2}{2}\right) + 12.6(30)\left(\frac{2.6}{2}\right)\right]$$
$$= 0.91(4241 + 41) = 3469 \text{ ft-k} > 14545$$

BENDING ABOUT TRANS AXIS
ASSUME LAST ROW OF STEEL IN COMPRESSION, NEXT ROW IS AT NEUTRAL AXIS AND REMAINING STEEL IN TENSION. $A_s = 4.2(4) - 8(0.2) = 15.2 \text{ in}^2$, $A_s' = 4(0.2) = 0.8 \text{ in}^2$

$$.85(2.5)(60)(12) + (.85)(2.5)(27)(x) + 0.8(30) = 15.2(30) + 1773$$
$$x = (456 + 1773 - 1530 - 24) \div 57.375 = 11.8''$$

$$M_{2m}' = 0.91\left[1530\left(\frac{37.25}{2} - \frac{0.85(12)}{2(12)}\right) + 57.375(11.8)\left(\frac{37.25}{2} - 1 - \frac{.85(11.8)}{2(12)}\right)\right.$$
$$+ 24\left(\frac{37.25}{2} - \frac{3}{2(12)}\right) + 456\left(\frac{23.8}{2(12)}\right)$$
$$= 0.91[27,946 + 11,650 + 444 + 452]$$
$$= 32,718 \text{ ft-k}$$

$$\frac{M_2}{M_{2m}'} + \frac{M_3}{M_{3m}'} = \frac{(2)14545}{3469} + \frac{(2)10175}{32718} = 8.39 + 0.62 = 9.01$$

SHEAR
$$V_n = (0.6)[16.8(30) + 1773] = 1366 \text{ KIPS}$$

$$V_{MAX} = \sqrt{(946)^2 - (1084)^2} = 2108 \text{ KIPS}$$

$$\text{RATIO} = \frac{2108}{1366} = 1.54$$

CENTER PIER, CENTER PORTION

| COMPONENT | RATIO MOMENT | RATIO SHEAR |
|---|---|---|
| PIER | | |
| TOP DOWELS | 15.3 | 2.14 |
| TOP SECTION | 1.16 | 1.26 |
| BOTTOM SECTION | 2.99 | 1.34 |
| BOTTOM DOWELS | 9.01 | 1.54 |

PLASTIC MOMENTS AT TOP & BOTTOM OF PIERS USING DOWELS

BENDING ABOUT LONGITUDINAL AXIS

TOP

$M_{RR_{GIRDER}} = 1.3(998) = 1294$ ft-k

$M_{2_T} = \cos 32^\circ (1294) = 1099$ ft-k

BOTTOM

$M_{2_B} = 1.3(6782) = 8817$ ft-k

SHEAR

$V_{TRANS} = \frac{1099 + 8817}{15} = 660$ KIPS

BENDING ABOUT TRANSVERSE AXIS

TOP

$M_{3_T} = \sin 32^\circ (1294) = 680$ ft-k

BOTTOM

$M_{3_B} = 1.3(32{,}719) = 42{,}533$ ft-k

$V_{LONG} = \frac{680 + 42533}{15} = 2881$

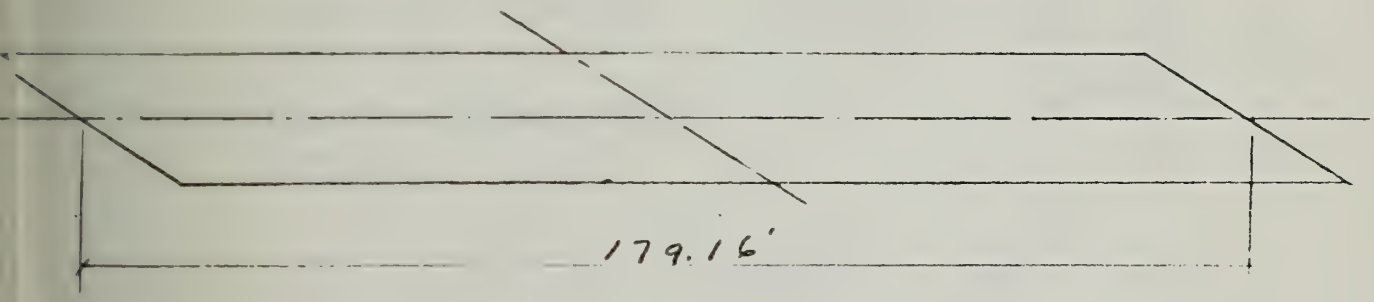
$V_{MAX} = \sqrt{(660)^2 + (2881)^2} = 2956^k \not< V_n = 936^k$

STATIC CHECK ON FORCES - RAILWAY PORTION

1. WT. OF SUPERSTRUCTURE = 11.4 K/FT

2. WT. OF CENTER PIER
$0.15(15 \times 4.62 \times 37.25 - 13.5 \times 2.37 \times 23) = 277^K$

3. SUPERSTRUCTURE LOAD APPLIED TO PIER = $1378^K$ (STATIC RXN)




SUPERSTRUCTURE WT. = $179 \times 11.4 = 2041^K$

LATERAL FORCE:
TAKE PEAK RESPONSE FROM CALTRANS SPECTRA.
= 1.63 G.

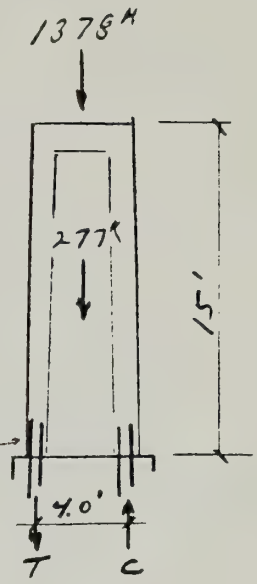
ASSUME Z = 2.0 FOR BENT & SUPERSTRUCTURE

EFFECTIVE FORCE = 0.82 G.

ASSUME CRITICAL CONDITION: SEISMIC FORCE APPLIED NORMAL TO BENT.

FORCE = $2041 \times 0.82 = 1670^K$

OVERTURNING RESISTANCE OF BENT




42-#4 DOWELS PER SIDE
ASSUME $f_y$ = 40 KSI

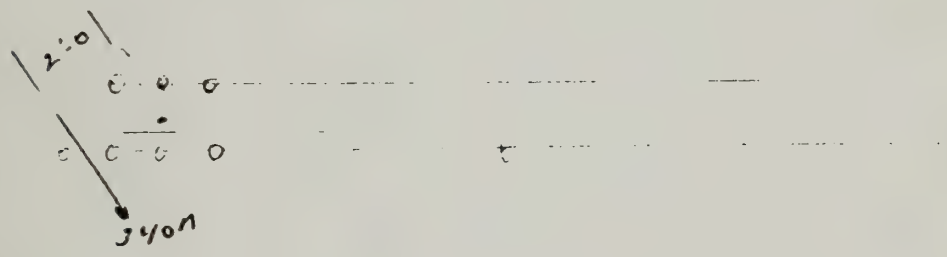
$\therefore T = 42 \times 0.2 \times 40 = 336^K$

RES. MOM = 336 x 4.0
+ 1655 x 2.0 = 4654

MAX. FORCE AT TOP OF PIER
= 4654/15 = 310^K

FORCE TO ABUTMENTS = $\frac{1670 - 310}{2}$ = 680^K EACH

RESTRAINER MUST RESIST 680^K ULTIMATE
ON TWO GIRDERS.




1" A325 BOLTS - PROOF LOAD = 51.5^K
USE PROOF LOAD AS ULTIMATE CAPACITY.

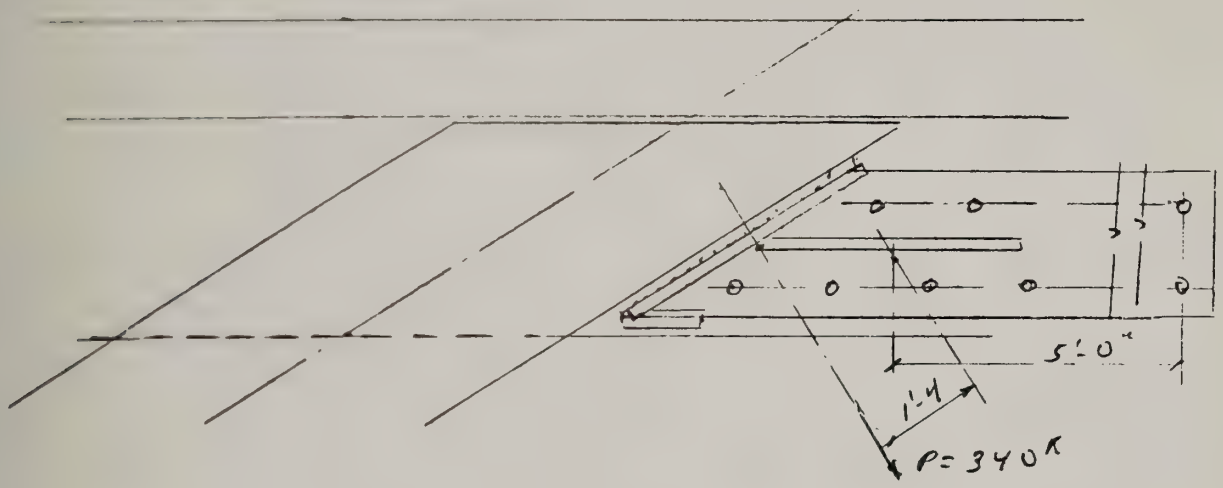
REQUIRED BEARING AREA AGAINST FACE OF GIRDER
USE $f_b = 0.7 f_c' = 2.1$ KSI

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 39

JOB MISSION ST. VICINITY BY PGG DATE 10-10-87

SUBJECT DESIGN OF RESTRAINER ANCHORAGE CHK'D DATE




6 BOLTS: $V_u = \frac{340}{6} = 57^K$ EACH > 51.5

USE $1\frac{1}{4}$" BOLTS - PROOF LOAD = $70.5^K$ (YIELD STRENGTH METHOD)

$$V_u = 57\left(1 + \frac{1.4}{5.0}\right) = 73^K$$

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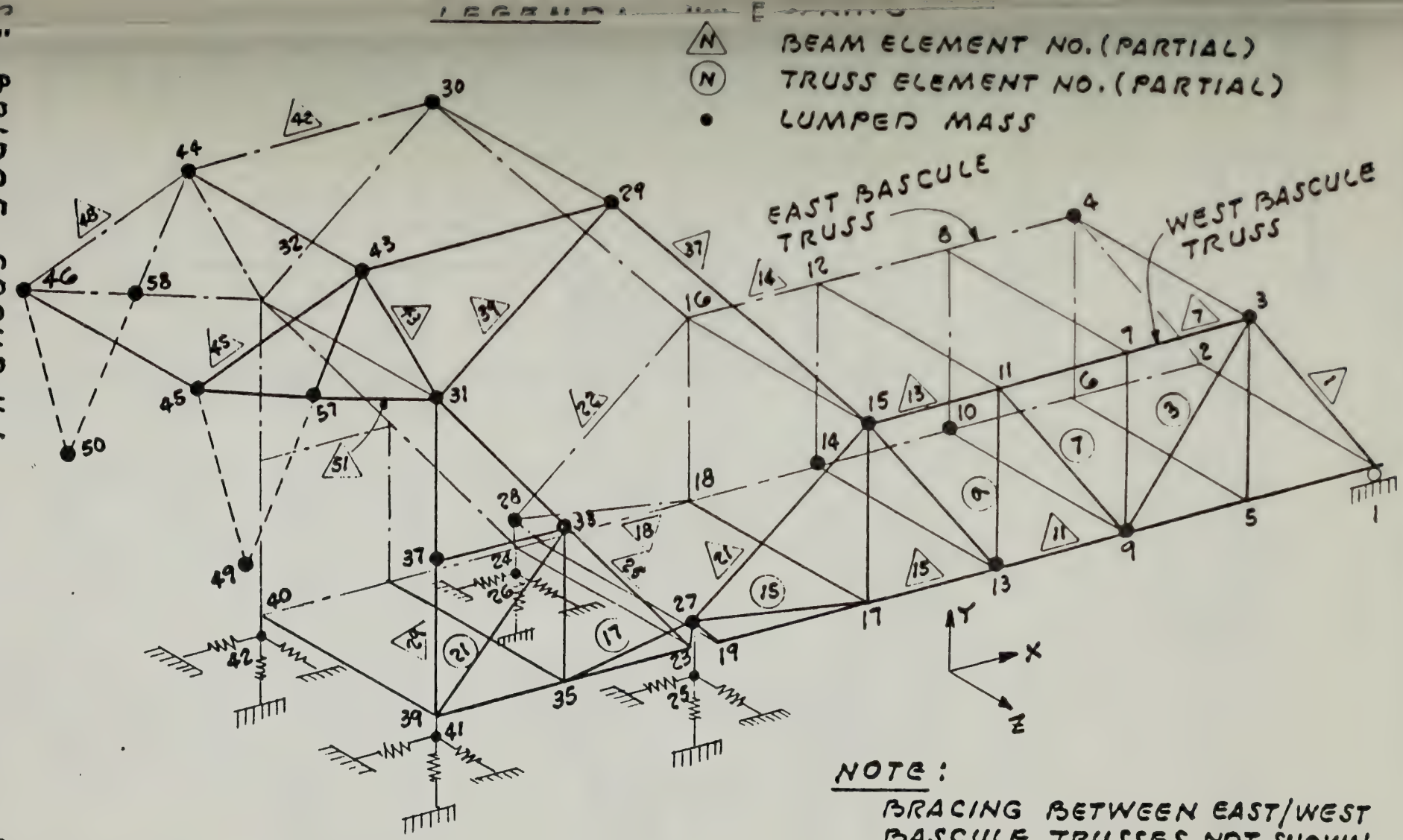
3. Evaluation ---------- 29 ~ 71

4. Computer printouts




NOTE:
BRACING BETWEEN EAST/WEST BASCULE TRUSSES NOT SHOWN

MATHEMATICAL MODEL - 3RD STREET BRIDGE OVER CHANNEL

FIGURE 2

S/BLUME
ssie Street (at New Montgomery)
rancisco, California 94105

SHEET NO. 2

NO. JOB S. F. Bridges BY CHC DATE 7/12/74

SUBJECT 3rd St. bridge CHK'D DATE

## Weight and Mass

### West Truss

| Nodal pt. | wt. (K) | wt. | Mass | |
|---|---|---|---|---|
| 1 | 87.5+12.8 = 100 | 50+8 +51.5 = | 110 = | 0.28 |
| 3 | 20.3-12.4 = 8 | | | |
| 5 | 102.9 | | | |
| 7 | 14.0 | 109.2 +51.5+14 = | 175 = | 0.45 |
| 9 | 109.2 | | | |
| 11 | 18.7 | 18.7+112 +62.5 = | 193 = | 0.50 |
| 13 | 112.0 | | | |
| 15 | 99.5 | 62.5+5+ 99.5 = | 167 = | 0.43 |
| 17 | 125.1 | | | |
| 19 | 77.0 | | | |
| 23 | 140.0 | | | |
| 27 | 10.2 | | = | |
| 29 | 75.0 | 30+75 = | 105 = | 0.27 |
| 31 | 150.0 | 30+150 = | 180 = | 0.47 |
| 33 | 80.0 | | | |
| 35 | 150.0 | 150+55 +70 = | 275 = | 0.71 |
| 37 | 150.0 | 80+150 = | 230 = | 0.60 |
| 39 | 110.0 | | | |
| 43 | 60.0 | | = | |
| 45 | 45.0 | | 675 = | 1.75 |
| 49 | 450. | | = | |
| 51 | 450 | | | |
| 55 | 450 | | 675 = | 1.75 |
| | 3,087 | | 2,785 | |

### East Truss

| Nodal pt. | wt. (K) | wt. | Mass | |
|---|---|---|---|---|
| 2 | 68.3+12.8 = 81 | 40.5+10 +35.8 = | 86 = | 0.22 |
| 4 | 22.1-12.4 = 10 | | | |
| 6 | 71.5 | | | |
| 8 | 14.1 | 77.5+14 35.8 = | 128 = | 0.33 |
| 10 | 77.5 | | | |
| 12 | 18.3 | 18.3+78.4 +43.9 = | 141 = | 0.36 |
| 14 | 78.4 | | | |
| 16 | 101.3 | 43.9+101.3 +5 = | 150 = | 0.37 |
| 18 | 87.8 | | | |
| 20 | 54.8 | | | |
| 24 | 130.0 | | | |
| 28 | 10.2 | | | |
| 30 | 68.0 | 68+26 = | 94 = | 0.24 |
| 32 | 141.0 | 141.+26 = | 167 = | 0.43 |
| 34 | 80.0 | | | |
| 36 | 170.0 | 170+65 +58 = | 293 = | 0.76 |
| 38 | 150.0 | 80+150 = | 230 = | 0.59 |
| 40 | 116.0 | | | |
| 44 | 52.0 | | | |
| 46 | 38.0 | | 525 = | 1.36 |
| 50 | 350. | | | |
| 52 | 350 | | | |
| 56 | 350 | | 525 = | 1.36 |
| | 2,600 | | 2,331 | |

Ref. Drawings : B-7582. B-22,752

/BLUME
ssie Street (at New Montgomery)
rancisco, California 94105

SHEET NO. 3

JOB S. F. Bridges BY [illegible] DATE [illegible]

SUBJECT 3rd St. Bridge CHK'D DATE

Beam Elements

| Mat I.D. | Member I.D. | Nodal pts | K | A | $A_v$ | $I_{2-2}$ | $I_{3-3}$ | Note |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1-3 | 4 | 31.44 | 26.2 | 1,810 | 7,074 | Bascule |
| 2 | 2 | 2-4 | 3 | 38.24 | 31.9 | 2,156 | 8,604 | Truss |
| 3 | 3 | 1-5 | 6 | 26.44 | 22.0 | 1,644 | 5,949 | |
| 3 | 4 | 2-6 | 5 | " | " | " | " | |
| 3 | 5 | 5-9 | 10 | " | " | " | " | |
| 3 | 6 | 6-10 | 9 | " | " | " | " | |
| 1 | 7 | 3-7 | 8 | 31.44 | 26.2 | 1,810 | 7,074 | |
| 1 | 8 | 4-8 | 7 | " | " | " | " | |
| 1 | 9 | 7-11 | 12 | " | " | " | " | |
| 1 | 10 | 8-12 | 11 | " | " | " | " | |
| 4 | 11 | 9-13 | 14 | 37.50 | 31.2 | 2,252 | 8,438 | |
| 1 | 12 | 10-14 | 13 | | | | | |
| 1 | 13 | 11-15 | 16 | | | | | |
| 1 | 14 | 12-16 | 15 | | | | | |
| 5 | 15 | 13-17 | 18 | 60.0 | 50.0 | 3,004 | 13,500 | |
| 6 | 16 | 14-18 | 17 | 46.44 | 38.7 | 2,310 | 10,470 | |
| 7 | 17 | 17-19 | 20 | 20 | 16.7 | 615 | 4,500 | |
| 8 | 18 | 18-20 | 19 | 23.6 | 19.7 | 678 | 10,260 | |
| 9 | 19 | 19-27 | 28 | ∞ | | ∞ | ∞ | |
| 9 | 20 | 20-28 | 27 | ∞ | | ∞ | ∞ | |
| 1 | 21 | 15-27 | 28 | | | | | |
| 10 | 22 | 16-28 | 27 | 41.72 | 34.8 | 2,506 | 9,387 | |
| 11 | 23 | 23-27 | 28 | 57.5 | 47.9 | 6,590 | 10,143 | Tower |
| 11 | 24 | 24-28 | 27 | " | " | " | " | Truss |
| 12 | 25 | 23-33 | 34 | 95.7 | 79.7 | 9,615 | 16,177 | |
| 13 | 26 | 24-34 | 33 | 79.0 | 65.6 | 8,166 | 13,350 | |
| 12 | 27 | 33-31 | 32 | 95.7 | 79.7 | 9,615 | 16,177 | |
| 13 | 28 | 34-32 | 31 | 79.0 | | | | |

S/BLUME
...ssie Street (at New Montgomery)
...rancisco, California 94105

SHEET NO. 4

NO. JOB S. F. Bridges BY CKC DATE 7/1/84

SUBJECT 3rd St. Bridge CHK'D DATE

Beam Elements

| Mat. I.D. | Member I.D. | Nodal pts | K | A | $A_v$ | $I_{2-2}$ | $I_{3-3}$ | Note |
|---|---|---|---|---|---|---|---|---|
| 14 | 29 | 39-37 | 38 | 155.9 | 130 | 16,990 | 25,130 | Tower Truss |
| " | 30 | 40-38 | 37 | | | | | |
| " | 31 | 37-31 | 32 | | | | | |
| " | 32 | 38-32 | 31 | | | | | |
| 15 | 33 | 23-35 | 36 | 62.5 | 52. | 3084 | 9000 | |
| 16 | 34 | 24-36 | 35 | 53.2 | 44.3 | 2,654 | 7,920 | |
| 17 | 35 | 35-39 | 40 | 32.5 | 27.1 | 2,083 | 4,680 | |
| 17 | 36 | 36-40 | 39 | " | " | " | " | |
| 18 | 37 | 15-29 | 30 | 84.75 | 70.6 | 41,847 | 2,552 | Link |
| 18 | 38 | 16-30 | 29 | " | " | " | " | " |
| 19 | 39 | 29-31 | 32 | 121.0 | 100.8 | 12,190 | 72,663 | CTWT |
| 20 | 40 | 30-32 | 31 | 98.0 | 81.6 | 9,707 | 46,328 | Truss |
| 21 | 41 | 29-43 | 44 | 126.4 | 105.3 | 13,092 | 74,300 | |
| 22 | 42 | 30-44 | 43 | 100.7 | 83.9 | 10,176 | 47,440 | |
| 23 | 43 | 31-43 | 44 | 88.0 | 73.3 | 6,597 | 52,037 | |
| 24 | 44 | 32-44 | 43 | 68.9 | 57.4 | 6,396 | 34,946 | |
| 25 | 45 | 43-45 | 46 | 90.5 | 75.4 | 9,130 | 53,505 | |
| 26 | 46 | 44-46 | 45 | 71.3 | 59.4 | 8,694 | 32,300 | |
| 27 | 47 | 43-57 | 58 | 81.5 | 67.9 | 6233 | 48,055 | |
| 28 | 48 | 44-58 | 57 | 60.9 | 50.7 | 5,462 | 29,467 | |
| 31 | 49 | 57-55 | 56 | ∞ | | ∞ | | |
| 31 | 50 | 58-56 | 55 | ∞ | | | | |
| 29 | 51 | 31-45 | 46 | 132.4 | 110.3 | 15,532 | 77,978 | |
| 30 | 52 | 32-46 | 45 | 105.7 | 88.1 | 12,055 | 49,891 | |
| 31 | 53 | 49-51 | 52 | ∞ | | ∞ | ∞ | |
| | 54 | 50-52 | 51 | | | | | C.T.WT. |
| | 55 | 51-53 | 54 | | | | | |
| | 56 | 52-54 | 53 | | | | | |
| | 57 | 49-55 | 56 | | | | | |
| | 58 | 50-56 | 55 | | | | | |
| | 59 | 55-53 | 54 | | | | | |
| | 60 | 56-54 | 53 | | | | | |

R/BLUME
Jessie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 5

O. JOB S. F. Bridges BY ERC DATE 7/12/80

N SUBJECT 3rd St. Bridge CHK'D DATE

Beam Elements

| Mat. I.D. | Member I.D. | Nodal pts | K | A | $A_v$ | $I_{2-2}$ | $I_{3-3}$ | Note |
|---|---|---|---|---|---|---|---|---|
| 32 | 61 | 53-45 | 46 | 59.2 | 49.3 | 4,185 | 9,041 | |
| 32 | 62 | 54-46 | 45 | 59.2 | 49.3 | 4,185 | 9,041 | |
| 33 | 63 | 1-2 | 39 | 84.6 | 70.5 | 34,420 | 521 | Floor Beam |
| | 64 | 5-6 | 39 | | | | | |
| | 65 | 9-10 | 39 | | | | | |
| | 66 | 13-14 | 39 | | | | | |
| | 67 | 17-18 | 39 | | | | | |
| | 68 | 19-20 | 39 | | | | | |
| | 69 | 35-36 | 39 | | | | | |
| 34 | 70 | 23-24 | 39 | 41.5 | 34.6 | 8,602 | 14.6 | |
| 35 | 71 | 39-40 | 36 | 155 | 129.2 | 74,420 | 48,610 | |
| 11 | 63 | 23-23 | 24 | | | | | Supports |
| 11 | 64 | 26-24 | 23 | | | | | |
| 11 | 65 | 41-39 | 40 | | | | | |
| 11 | 66 | 42-40 | 39 | | | | | |
| 36 | 76 | 25-26 | 41 | 1,526. | 1,282 | 1,176,198 | 32,523 | Conc. Tie Beam 1.33 × 8' |
| 37 | 77 | 3-4 | 15 | 12.1 | 10.0 | 21,521 | 2,745 | Horiz. Ties - Top of |
| " | 78 | 7-8 | 15 | " | " | " | " | Truss |
| " | 79 | 11-12 | 15 | " | " | " | " | " |
| " | 80 | 15-16 | 3 | " | " | " | " | " |
| 38 | 81 | 31-32 | 23 | 24.2 | 20.0 | 5,490 | 106,286 | Horiz. Tie - Trunnion |
| 39 | 82 | 33-34 | 23 | " | 20.0 | 5490 | 49,410 | Tower |

/BLUME
asie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 5

JOB S. F. Bridges BY CIC DATE 7/[illegible]

SUBJECT 3rd St. Bridge CHK'D DATE

Truss Elements

| Mat. I.D. | Member I.D. | Nodal pts | A | Section |
|---|---|---|---|---|
| 1 | 1 | 3-5 | 20.0 | 4 - ∠s 7 × 3½ × ½ |
| 2 | 2 | 4-6 | 22.4 | 4 - ∠s 7 × 3½ × 9/16 |
| 3 | 3 | 3-9 | 23.4 | 2 - C 15 × 40 # |
| 4 | 4 | 4-10 | 26.3 | 2 - C 15 × 45 # |
| 5 | 5 | 7-9 | 19.80 | 2 - C 15 × 33.9 # |
| 5 | 6 | 8-10 | " | " |
| 6 | 7 | 9-11 | 31.44 | 4 - ∠s 4 × 4 × 3/8, 2 - PLs 20 × ½ |
| 7 | 8 | 10-12 | 28.94 | 4 - ∠s 4 × 4 × 3/8, 2 - PLs 20 × 7/16 |
| 8 | 9 | 11-13 | 29.28 | 2 - C 15 × 50 # |
| 4 | 10 | 12-14 | 26.34 | 2 - C 15 × 45 |
| 9 | 11 | 13-15 | 47.50 | 4 - ∠s 4 × 4 × ½, 2 - PLs 20 × 13/16 |
| 10 | 12 | 14-16 | 45.00 | 4 - ∠s 4 × 4 × ½, 2 - PLs 20 × ¾ |
| 11 | 13 | 15-17 | 27.0 | 4 - ∠s 7 × 3½ × 11/16 |
| 11 | 14 | 16-18 | 27.0 | " |
| 12 | 15 | 17-27 | 70.94 | 4 - ∠s 4 × 4 × 5/8, 2 PLs 20 × 1 5/16 |
| 13 | 16 | 18-28 | 51.72 | 4 - ∠s 4 × 4 × 9/16, 2 PLs 20 × ⅞ |
| 14 | 17 | 27-35 | 55.0 | 4 - ∠s 4 × 4 × ½, 2 PLs 20 × 1 |
| 15 | 18 | 28-36 | 43.24 | 4 - ∠s 4 × 4 × 7/16, 2 PLs 20 × ¾ |
| 16 | 19 | 33-35 | 30.24 | 4 - ∠s 4 × 4 × ½, 2 PLs 20 × 1 |
| 17 | 20 | 34-36 | 33.44 | 4 - ∠s 4 × 4 × 7/16, 2 PLs 20 × ¾ |
| 6 | 21 | 33-39 | 31.44 | |
| 6 | 22 | 34-40 | 31.44 | |
| 18 | 23 | 33-37 | 78.16 | 4 - ∠s 4 × 4 × 5/8, 2 web PLs 46 × ⅜, |
| 18 | 24 | 34-38 | " | 2 ∠s 4 × 4 × 5/8 w/, cover PL 29 × ½ |

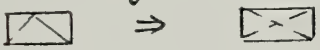
'BLUME
e Street (at New Montgomery)
ncisco, California 94105

SHEET NO. 7

JOB S. F. Bridges BY CKC DATE 7/6/54

SUBJECT 3rd St. Bridge CHK'D DATE

Truss Elements

| Mat. I.D. | Member I.D. | Nodal pts | A | Section |
|---|---|---|---|---|
| 19 | 25 | 1-6 | 6.10 | Floor Diagonal - 2 ∠s 5 × 3½ × 3/8 |
| | 26 | 5-2 | | |
| | 27 | 5-10 | | |
| | 28 | 9-6 | | |
| | 29 | 9-14 | | |
| | 30 | 13-10 | | |
| | 31 | 13-18 | | |
| 19 | 32 | 17-14 | | |
| 20 | 33 | 17-20 | 16.0 | see cal. |
| 20 | 34 | 19-18 | " | |
| 19 | 35 | 23-36 | 6.10 | Floor Diagonal - 2 - ∠s 5 × 3½ × 3/8 |
| | 36 | 35-24 | | |
| | 37 | 35-40 | | |
| | 38 | 39-36 | | |
| 21 | 39 | 3-8 | 12.6 | Equiv. Diag. on top of Truss |
| | 40 | 7-4 | |  see cal. |
| | 41 | 7-12 | | |
| | 42 | 11-8 | | |
| | 43 | 11-16 | | |
| | 44 | 15-12 | | |
| 22 | 45 | 15-30 | 19.6 | CTWT. Link Bracing - Equiv Area |
| 22 | 46 | 29-16 | " | see cal. |
| 23 | 47 | 29-44 | 11.4 | CTWT Truss, - 4 - ∠4 × 4 × 3/8 |
| | 48 | 43-30 | " | |
| | 49 | 43-46 | 11.4 | |
| | 50 | 45-44 | " | |
| | 51 | 29-32 | " | |
| | 52 | 31-30 | " | |
| 24 | 53 | 31-44 | 39 | |
| 24 | 54 | 43-32 | " | |

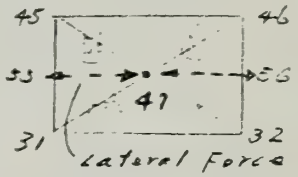
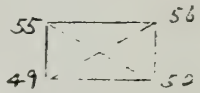
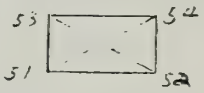
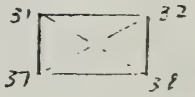
RS/BLUME
Jesse Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 8

JOB S. F. Bridges — BY EVC — DATE 7/1/12

SUBJECT 3rd St Bridge — CHK'D — DATE

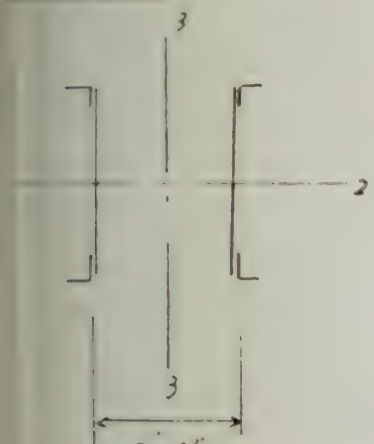
Truss Elements

| Mat. I.D. | Member I.D. | Nodal pts | A | Section |
|---|---|---|---|---|
| 25 | 55 | 31-47 | 21.2 | 4-Ls 6 x 4 x 9/16 |
| 26 | 56 | 43-47 | 16.7 | 4-Ls 6 x 4 x 7/16 |
| 26 | 57 | 32-47 | 16.7 | 4-Ls 6 x 4 x 7/16 |
| 25 | 58 | 46-47 | 21.2 | 4-Ls 6 x 4 x 9/16 |
| | | | |   Lateral Force connector |
| 27 | 59 | 49-56 | 14.6 | } Equiv. see Cal.   |
| 27 | 60 | 55-50 | 14.6 | |
| 28 | 61 | 51-54 | 24.4 | } Equiv. see Cal.   |
| 28 | 62 | 53-52 | 24.4 | |
| 29 | 63 | 37-32 | 52 | } Equiv. see Cal.   |
| 29 | 64 | 31-38 | 52 | |
| 30 | 65 | 3-4 | 16.1 | 4-Ls 3 1/2 x 3 1/2 x 3/8, 2-Ls 5 x 3 1/2 x 3/8 |
| ~~30~~ | 66 | 7-8 | 16.1 | 2 x 5 + 6.1 = 16.1 |
| 30 | 67 | ~~11-12~~ | 16.1 | } Top tie for truss |
| ~~31~~ | 68 | ~~15-16~~ | 32.2 | |
| 32 | ~~29~~ 65 | 29-30 | 12.2 | 4-Ls 5 x 3 1/2 x 3/8 |
| 33 | ~~72~~ 66 | 43-44 | 5.8 | 4-L 4 x 4 x 3/8 |
| 32 | ~~71~~ 67 | 45-46 | 12.2 | 4-Ls 5 x 3 1/2 x 3/8 |
| 34 | 72 | 31-32 | 24.4 | 8-Ls 5 x 3 1/2 x 3/8 |
| ~~35~~ | 73 | 33-34 | ∞ | } Conc. Fl. Deck - Machine Room |
| | ~~74~~ 68 | 37-38 | ∞ | |
| | ~~75~~ 69 | 55-47 | ∞ | } Connector |
| | ~~76~~ 70 | 56-47 | ∞ | |
| 36 | ~~77~~ 71 | 57-58 | 114.8 | } ass. the same. |
| " | ~~78~~ 72 | 53-54 | 114.8 | see Cal. |

Member properties

1-3 : 4-Ls 4 × 4 × 3/8 , 2 - Pls 20 × 1/2

A = 2.86 Ea. A = 10.0 , $I = \frac{1}{12} \times 20^3 \times \frac{1}{2} = 333$




$\ell = \sqrt{315^2 + 402^2} = 510.8''$

$\Sigma A = 4 \times 2.86 + 2 \times 10$

$= 31.44$ ✓

$I_{2-2} = 2 \times 333 + 4 \times 2.86 \times 10^2$

$= 666 + 1{,}144 = 1{,}810 \text{ in}^4$

$I_{3-3} = 2 \times 10 \times 15^2 + 4 \times 2.86 \times 15^2$

$= 7{,}074$

1-4 : 4-Ls 4 × 4 × 7/16 , 2 - Pls 20 × 5/8

A = 3.31 in², A = 12.5 , I = 416

$\Sigma A = 4 \times 3.31 + 2 \times 12.5$

$= 13.24 + 25 = 38.24$ ✓

$I_{2-2} = 2 \times 416 + 4 \times 3.31 \times 10^2$

$= 832 + 1{,}324 = 2{,}156$

$I_{3-3} = 2 \times 12.5 \times 15^2 + 4 \times 3.31 \times 15^2$

$= 8{,}664$

1-5 : 4 - Ls 4 × 4 × 3/8 ; 2 - Pls 20 × 3/8

2-6, 5-9, 6-10 } A = 2.86 ; A = 7.5 , I = 250

$\Sigma A = 4 \times 2.86 + 2 \times 7.5 = 26.44$ ✓

$I_{2-2} = 2 \times 250 + 4 \times 2.86 \times 10^2$

$= 1646$

$I_{3-3} = 2 \times 7.5 \times 15^2 + 4 \times 2.86 \times 15^2$

$= 5945$

member properties

1-7 : 4 - ∠s 4 × 4 × 3/8 , 2 - PLs 20 × 1/2

1-8, 1-11, 1-12 } Same as 1-3 ✓

1-13 : 4 - ∠s 4 × 4 × 1/2 , 2 - PLs 20 × 9/16

A = 3.75 , A = 11.25 , I = 375

$\Sigma A = 4 \times 3.75 + 2 \times 11.25 = 37.5$ ✓

$I_{2-2} = 2 \times 376 + 4 \times 3.75 \times 10^2$

$= 752 + 1500 = 2252$

$I_{3-3} = 2 \times 11.25 \times 15^2 + 4 \times 3.75 \times 15^2$

$= 8,438$

1-14 : Same as 1-3

1-15 : Same as 1-3 ✓

1-16 : Same as 1-3 ✓

1-17 : 4 - ∠s 4 × 4 × 1/2 , 4 - PLs 20 × 5/16

$\Sigma A = 37.5 + 2 \times 11.25 = 60$ ✓

$I_{2-2} = 4 \times 376 + 4 \times 3.75 \times 10^2 = 3,004$

$I_{3-3} = 4 \times 11.25 \times 15^2 + 4 \times 3.75 \times 15^2 = 13,500$

1-18 : 4 - ∠s 4 × 4 × 3/8 ; 2 - PLs 20 × 7/8

A = 2.86 , A = 17.5 , I = 583

$\Sigma A = 4 \times 2.86 + 2 \times 17.5 = 46.44$ ✓

$I_{2-2} = 2 \times 583 + 4 \times 2.86 \times 10^2$

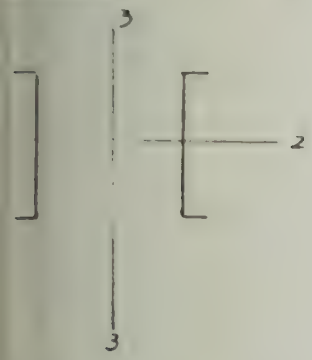
$= 2,310$

$I_{3-3} = 2 \times 17.5 \times 15^2 + 4 \times 2.86 \times 15^2$

$= 10,467$

Member properties

1-19 : 2 [s 15 × 33.9#  A = 9.96,  I = 315




$A = 20$

$I_{2-2} = 615$

$I_{3-3} = 2 \times 10 \times 15^2 = 4500$

1-20 : 2 - [s 15 × 40#  A = 11.8,  I = 349

$A = 236$

$I_{2-2} = 2 \times 349 = 698$

$I_{3-3} = 2 \times 11.8 \times 15^2 = 10,260$

1-27 : Same as 1-3

1-28 : 4 - ∠s 4 × 4 × 9/16,  2 Pls 20 × 5/8

$A = 4.18$  $A = 12.5$,  $I = 417$

$\Sigma A = 4 \times 4.18 + 2 \times 12.5$

$= 16.72 + 25 = 41.72$ ✓

$I_{2-2} = 2 \times 417 + 4 \times 4.18 \times 10^2$

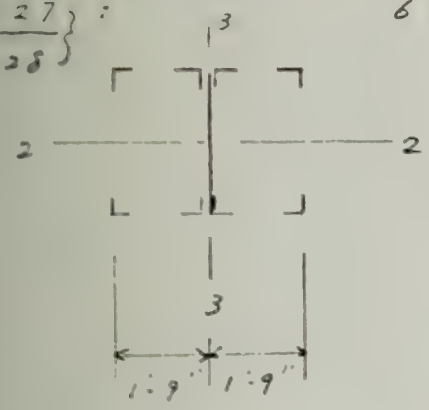
$= 834 + 1672 = 2,506$

$I_{3-3} = 4 \times 4.18 \times 15^2 + 2 \times 12.5 \times 15^2$

$= 9,387$

Span Elements

23-27 / 24-28 :




6 - ∠s 6 × 6 × 1/2 , w/ 1 - web PL 23 × 1/2

$A = 5.75 \text{ in}^2$

$\Sigma A = 8 \times 5.75 + 23 \times 0.5$

$= 57.5$

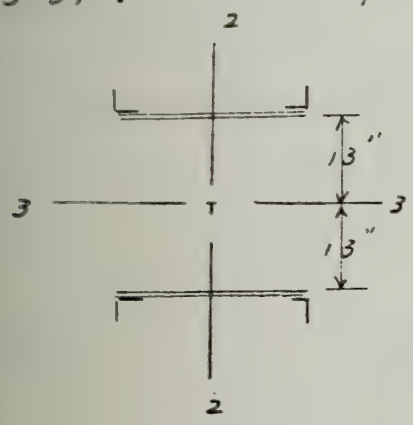
$I_{2-2} = 4 \times 2 \times 5.75 \times (11.5)^2 + \frac{1}{12} \times 0.5 \times 23^3$

$= 6084 + 507 = 6{,}590 \text{ in}^4$

$I_{3-3} = 4 \times 5.75 \times (21)^2$

$= 10{,}143 \text{ in}^4$

23-33-31 :




4 - ∠s 6 × 6 × 9/16 , 4 - PLs 28 × 1/4

$A = 6.43 \text{ in}^2$ $A = 35$

$I = 2{,}287$

$\Sigma A = 4 \times 6.43 + 2 \times 35$

$= 25.72 + 70 = 95.7 \text{ in}^2$

$I_{3-3} = 4 \times 6.43 \times (13)^2 + 2 \times 35 \times 13^2$

$= 4{,}347 + 11{,}830 = 16{,}177$

$I_{2-2} = 2 \times 2287 + 4 \times 6.43 \times 14^2$

$= 4{,}574 + 5{,}041 = 9{,}615$

24-34-32 :

4 - ∠s 6 × 6 × 1/2 , 4 - PLs 28 × 1

$A = 5.75$ , $A = 28 \times 1 = 28$

$I = 1{,}829$

$\Sigma A = 4 \times 5.75 + 2 \times 28 = 79$

$I_{22} = 4 \times 5.75 \times 14^2 + 2 \times 1829$

$= 4{,}508 + 3{,}658 = 8{,}166$

$I_{3-3} = 4 \times 5.75 \times (13)^2 + 2 \times 28 \times 13^2$

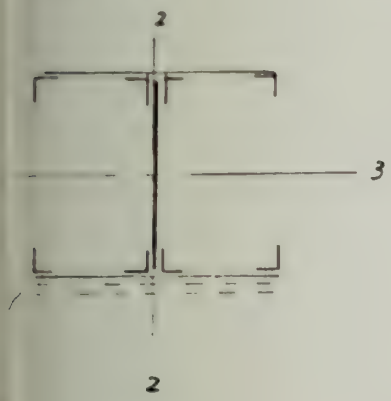
3887 9464

$= 13{,}351$

Beam Element

19-37-31 } : 8 - ∠s 6 × 6 × 5/8 , 1 - web Pl 27 × 1 ,
0-38-32 } 2 cov. Pls 36 × 1

A = 7.11




$\Sigma A = 8 \times 7.11 + 27 \times 1 + 2 \times 36 \times 1$

$= 56.88 + 27 + 72 = 155.88 \text{ in}^2$

drawing 3

$I_{3-3} = 8 \times 7.11 \times \left(\frac{27}{2}\right)^2 + 2 \times 36 \times (15.5)^2$

$+ \frac{1}{12} \times 27^3 \times 1 + \ldots$

$= 12{,}366 + 13{,}122 + 1{,}640$

$= 25{,}128 \text{ in}^4$

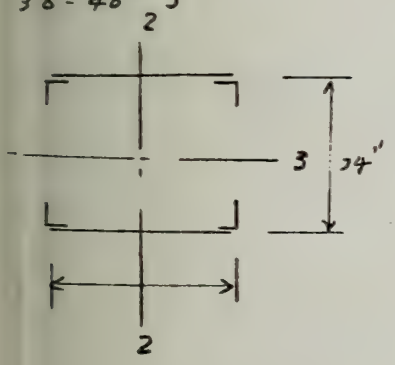
* Additional cover Pls @ ends of the element

$I_{2-2} = 2 \times \frac{1}{12} \times 36^3 + 4 \times 7.11 \times 18^2$

$= 7{,}776 + 9{,}215$

$= 16{,}990 \text{ in}^4$

35 - 39 } : 4 - ∠s 4 × 4 × 1/2 , 2 - Pls 20 × 7/16
36 - 40 } A = 3.75




$\Sigma A = 4 \times 3.75 + 2 \times 20 \times 7/16$

$= 15 + 17.5 = 32.5$

$I_{3-3} = 2 \times 2 \times 3.75 \times 12^2 + 2 \times 20 \times 7/16 \times 12^2$

$= 32.5 \times 144 = 4{,}680 \text{ in}^4$

$I_{2-2} = \frac{1}{12} \times 2 \times \frac{7}{16} \times 20^3 + 4 \times 3.75 \times 10^2$

$= 583 + 1500 = 2{,}083 \text{ in}^4$

## Member properties

23-35 : 4 - Ls 4 x 4 x 1/2 ; 2 - Pls 20 x 1 3/16

r = 3.25 A = 23.75

I = 792

$A = 4 \times 3.75 + 2 \times 23.75$

$= 62.5$

$I_{2-2} = 2 \times 792 + 2 \times 3.75 \times 10^2$

$= 1584 + 1500 = 3{,}084$

$I_{3-3} = 4 \times 3.75 \times 12^2 + 2 \times 23.75 \times 12^2$

$= 9{,}000$

24-36 : 4 - Ls 4 x 4 x 7/16 ; 2 - Pls 20 x 1

A = 3.31 A = 20

I = 667

$A = 4 \times 3.31 + 40 = 13.2 + 40 = 53.2$ ;

$I_{2-2} = 2 \times 667 + 13.2 \times 10^2$

$= 1334 + 1320 = 2{,}654$

$I_{3-3} = 2 \times 20 \times 12^2 + 4 \times 3.75 \times 12^2$

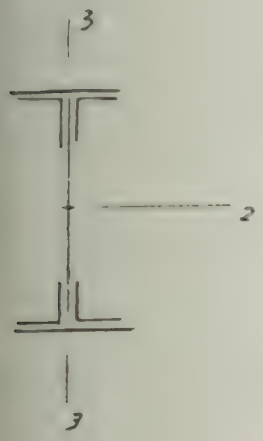
$= 7{,}920$

Member properties

15-29, 16-30 :

4 - Ls 8 x 8 x 1/2 , 1 - web Pl 54 x 5/8
A = 7.75 A = 33.75 , I = 8201

2 - cov. Pl 20 x 1/2
A = 10, I = 333



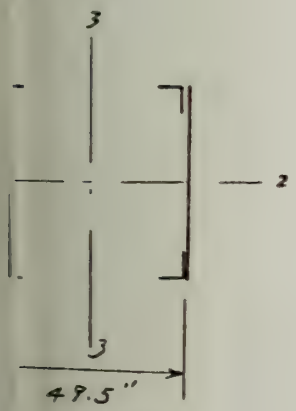

$A = 4 \times 7.75 + 33.75 + 20$
$= 84.75$

$I_{2-2} = 4 \times 7.75 \times (27 - 2.2)^2 + 8201 + 20 \times 27^2$
$= 19{,}066 + 8201 + 14{,}580$
$= 41{,}847$ ✓

$I_{3-3} = 2 \times 333 + 4 \times 7.75 \times (10 - 2.2)^2$
$= 2{,}552$

29-31 :

4 - Ls 6 x 6 x 11/16 , 2 - Pls 30 x 1 1/2
A = 7.77, A = 45
$\bar{x}$ = 1.77 I = 3375




$A = 4 \times 7.77 + 2 \times 4.5$
$= 121$ ✓

$I_{2-2} = 2 \times 3375 + 4 \times 7.77 \times (15 - 1.77)^2$
$= 6{,}750 + 5{,}440 = 12{,}190$

$I_{3-3} = 4 \times 7.77 \times (49.5/2 - 1.77)^2 + 2 \times 4.5 \times \left(\frac{49.5}{2}\right)^2$
$= 16{,}413 + 56250 = 72{,}663$

30-32 :

4 - Ls 6 x 6 x 1/2 , 2 Pls 30 x 1 1/4
A = 5.75, $\bar{x}$ = 1.68, A = 37.5, I = 2813

$A = 4 \times 5.75 + 2 \times 37.5 = 98$ ✓

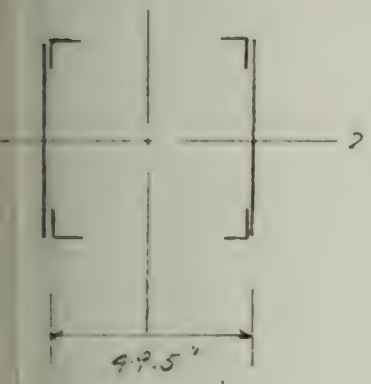
$I_{2-2} = 2 \times 2813 + 4 \times 5.75 \times (15 - 1.68)^2 = 9707$

$I_{3-3} = 4 \times 5.75 \times \left(\frac{44.25}{2} - 1.68\right)^2 + 2 \times 37.5 \times \left(\frac{44.25}{2}\right)^2$
$= 46{,}328$

Member properties

29 - 43 : 4 - Ls 6 x 6 x 13/16 ; 2 - Pls 30 x 1 1/2

A = 9.1, $\bar{x}$ = 1.8, A = 45, I = 3375




$A = 4 \times 9.1 + 2 \times 45 = 126.4$ ✓

$I_{2-2} = 2 \times 3375 + 4 \times 9.1 \times (15 - 1.8)^2$

$= 6{,}750 + 6{,}342 = 13{,}092$

$I_{3-3} = 4 \times 9.1 \times \left(\frac{49.5}{2} - 1.8\right)^2 + 90 \times \left(\frac{29.5}{2}\right)^2$

$= 19{,}172 + 55{,}131 = 74{,}303$

30 - 44 : 4 - Ls 6 x 6 x 9/16 , 2 - Pls 30 x 1/4

A = 6.43, $\bar{x}$ = 1.7, A = 37.5, I = 2,813

$A = 4 \times 6.43 + 2 \times 37.5 = 100.72$ ✓

$I_{2-2} = 2 \times 2813 + 4 \times 6.43 \times (15 - 1.7)^2$

$= 10{,}176$

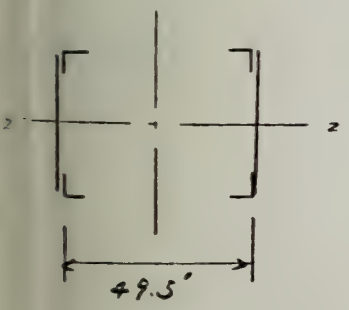
$I_{3-3} = 4 \times 6.43 \times \left(\frac{44.25}{2} - 1.7\right)^2 + 2 \times 37.5 \times \left(\frac{44.25}{2}\right)^2$

$= 10{,}729 + 36{,}714 = 47{,}443$

1 - 43 : 4 - Ls 6 x 6 x 1/2 ; 2 Pls 26 x 1 1/4

A = 5.75 A = 32.5

$\bar{x}$ = 1.7, I = 1,830




$A = 4 \times 5.75 + 2 \times 32.5$

$= 23 + 65 = 88$ ✓

$I_{2-2} = 2 \times 1830 + 4 \times 5.75 \times (13 - 1.7)^2$

$= 3660 + 2{,}936 = 6{,}597$

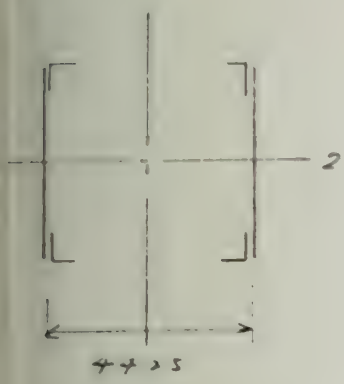
$I_{3-3} = 23 \times \left(\frac{49.5}{2} - 1.7\right)^2 + 65 \times \left(\frac{26.5}{2}\right)^2$

$= 12{,}220 + 39{,}816 = 52{,}037$

## Member Properties

32 - 43 : 4 - Ls 6 x 6 x 13/16 ; 2 - PLs 24 x 5/8

A = 9.1, $\bar{x}$ = 1.8 ; A = 16.25 , I = 915



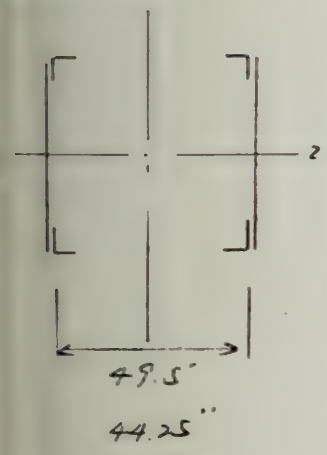

A = 4 x 9.1 + 2 x 16.25
= 36.4 + 32.5 = 68.9

$I_{2-2}$ = 2 x 915 + 4 x 9.1 x (13 - 1.8)$^2$
= 1,830 + 4516 = 6,316

$I_{3-3}$ = 2 x 16.25 x (44.25/2)$^2$ + 4 x 9.1 x ($\frac{44.25}{2}$ - 1.8)$^2$
= 15,909 + 15,437 = 31,946

3 - 45 : 4 - Ls 6 x 6 x 1/2 ; 2 - PLs 30 x 1 1/8

A = 5.75 A = 33.75
$\bar{x}$ = 1.7 I = 2531




A = 4 x 5.75 + 2 x 33.75
= 23 + 67.5 = 90.5 ✓

$I_{2-2}$ = 2 x 2531 + 23 x (15 - 1.7)$^2$
= 5062 + 4068 = 9130

$I_{3-3}$ = 23 x ($\frac{49.5}{2}$ - 1.7)$^2$ + 2 x 33.75 x ($\frac{49.5}{2}$)$^2$
= 12,219 + 41,287 = 53,505

44 - 46 : 4 - Ls 6 x 6 x 3/4 ; 2 - PLs 30 x 5/8

A = 8.44, $\bar{x}$ = 1.8, A = 18.75 , I = 1406

A = 4 x 8.44 + 2 x 18.75
= 33.76 + 37.5 = 71.26 ✓

$I_{2-2}$ = 2 x 1406 + 33.76 x (15 - 1.8)$^2$
= 2812 + 5882 = 8694

$I_{3-3}$ = 33.76 x ($\frac{44.25}{2}$ - 1.8)$^2$ + 37.5 x ($\frac{44.25}{2}$)$^2$
= 13,946 + 18,357 = 32,303

## Element properties

43-55 : 4 - Ls 6 x 6 x 1/2 ; 2 - PLs 26 x 1 1/8

$A = 5.75$ $\quad$ $A = 29.25$

$\bar{x} = 1.7$ $\quad$ $I = \frac{1}{12} \times 26^3 \times 1.125 = 1,766$

$A = 4 \times 5.75 + 2 \times 29.25$

$= 23 + 58.5 = 81.5$ ✓

$I_{2-2} = 2 \times 16.8 + 4 \times 5.75 \times (13 - 1.7)^2$

$= 33,36 + 2,937 = 6,233$

$I_{3-3} = 23 \times (\frac{49.5}{2} - 1.7)^2 + 2 \times 29.25 \times (\frac{49.5}{2})^2$

$= 12,220 + 35,835 = 48,055$

44-56 : 4 - Ls 6 x 6 x 5/8 ; 2 - PLs 26 x 5/8

$A = 7.11, \quad \bar{x} = 1.7 \qquad A = 16.25, \quad I = 915$

$A = 4 \times 7.11 + 2 \times 16.25 = 28.44 + 32.5$

$W = 44.25"$ $\quad = 60.9$ ✓

$I_{2-2} = 2 \times 915 + 4 \times 7.11 \times (13 - 1.7)^2$

$= 1830 + 3132 = 5,462$

$I_{3-3} = 2 \times 16.25 \times (\frac{44.25}{2} - 1.7)^2 + 2 \times 16.25 \times (\frac{44.25}{2})^2$

$= 13,358 + 15,909 = 29,467$

Element properties

2-43 : 4 - ∠s 6 × 6 × 13/16 ; 2 - PLs 32 × 1 1/2

A = 9.1, $\bar{x}$ = 1.8 ; A = 48, I = 4,096

A = 4 × 9.1 + 2 × 48 = 36.4 + 96

= 132.4 ✓

$I_{2-2}$ = 4 × 9.1 × (16 − 1.8)² + 2 × 4096

= 7,340 + 8,192 = 15,532

$I_{3-3}$ = 4 × 9.1 × ( 49.5/2 − 1.8)² + 96 × ( 49.5/2 )²

= 19,172 + 58,806

= 77,978

3-46 : 4 - ∠s 6 × 6 × 7/16 ; 2 - PLs 32 × 1/4

A = 6.43, $\bar{x}$ = 1.7 ; A = 40, I = 3413

W = 44.25"

A = 4 × 6.43 + 2 × 40 = 25.72 + 80 = 105.7

$I_{2-2}$ = 25.72 × (16 − 1.7)² + 2 × 3413

= 5,259 + 6,826 = 12,085

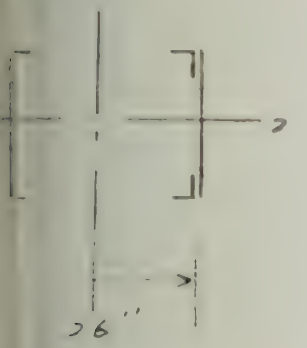
$I_{3-3}$ = 4 × 6.43 × ( 44.25/2 − 1.7)² + 80 × ( 44.25/2 )²

= 10,730 + 39,161 = 49,891

Beam Elements

53-45, 54-46 : 4 - Ls 6 x 6 x 1/2 ; 2 - PLs 24 x 3/4

A = 5.79, $\bar{x}$ = 1.7, A = 18, I = 864




$A = 4 \times 5.79 + 2 \times 18$

$= 23.16 + 36 = 59.16$

$I_{2-2} = 2 \times 864 + 4 \times 5.79 \times (12 - 1.7)^2$

$= 1728 + 2457 = 4{,}185$

$I_{3-3} = 2 \times 18 \times (13)^2 + 4 \times 5.79 \times (13 - 1.7)^2$

$= 6{,}084 + 2957 = 9{,}041$

57-58 :

Top - 4 - Ls 4 x 4 x 5/8, A = 4.61 x 4 = 18.4
2 - PLs 20 x 3/4 A = 15 x 2 = 30
2 - PLs 12 x 3/8 A = 4.5 x 2 = 9.0
} 57.4

Bottom : Same

A = 2 x 57.4 = 114.8

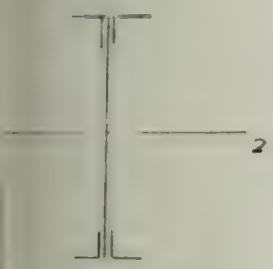
45-46 :

Top - 4 - Ls 4 x 4 x 5/8, A = 4.61 x 4 = 18.4
2 - PLs 20 x 5/8 A = 12.5 x 2 = 25
2 - PLs 12 x 5/8 A = 7.5 x 2 = 15
} 58.4

A = 2 x 58.4 = 116.8

Floor Beams

1 - 2 :




4 - ∠s 8 × 8 × 3/4 , Web Pl 52 × 3/4

A = 11.4 A = 39

$\bar{x}$ = 2.3 I = 5788

A = 4 × 11.4 + 39 = 87.6

$I_{22}$ = 4 × 11.4 × (52/2 - 2.3)² + 5788

= 34401

For 1 - 2
5 - 6
9 - 10
13 - 14
17 - 18
19 - 20
35 - 36

$I_{33}$ = 4 × 11.4 × 2.3² + 4 × 70

= 521

assumed same for all

23 - 24 : 4 - ∠s 6 × 6 × 1/2 , Web Pl 37 × 1/2

A = 5.75 A = 18.5

$\bar{x}$ = 1.7 I = 2110

A = 4 × 5.75 + 18.5 = 41.5

$I_{2-2}$ = 4 × 5.75 × (18.5 - 1.7)² + 2110

= 8,602

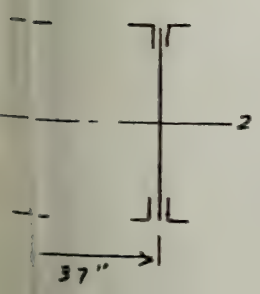
$I_{3-3}$ = 4 × 5.75 × 1.7² + 4 × 18.5

= 146

39 - 40 : 8 - ∠s 6 × 6 × 3/4 , A = 8.44, $\bar{x}$ = 1.8 2 - Webs 52 × 1/2 , A = 26 I = 5858

4 cover Pls 14 × 5/8 full length

A = 8.75




A = 8 × 8.44 + 2 × 26 + 4 × 8.75 = 155

$I_{2-2}$ = 8 × 8.44 × (26 - 1.8)² + 2 × 5858 + 4 × 8.75 × 26²

= 39,542 + 11,716 + 23,660 = 74,918

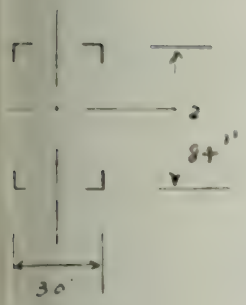
$I_{3-3}$ = 8 × 8.44 × (18.5 - 1.8)² + 2 × 26 × 18.5² + 4 × 8.75 × 18.5²

= 18,831 + 17,797 + 11,979 = 48,607

Beam Elements - Horiz Ties

△2 ~ △8 : 4 - ∠s × 3½ × ⅜ Top — A = 2 × 6.1
2 - ∠s 5 × 3½ × ⅜ Bottom A = 6.1

use A = 6.1 + 6.1 = 12.1




$I_{2-2} = 6.1 \times 2 \times 42^2 = 21{,}521 \text{ in}^4$

$I_{3-3} = 6.1 \times 2 \times 15^2 = 2745 \text{ in}^4$

$S_{2-2} = 512$

$S_{3-3} = 183$

△1 : 4 - ∠s 5 × 3½ × ⅜ Top & Bottom

31~32

$A = 2 \times 6.1 + 2 \times 6.1 = 24.2 \text{ in}^2$

$I_{2-2} = 4 \times 6.1 \times (15)^2 = 2745 \times 2 = 5490 \text{ in}^4$

$S_{2-2} = 5490/15 = 366 \text{ in}^3$

$I_{3-3} = 4 \times 6.1 \times (\frac{11}{2} \times 12)^2 = 106{,}286 \text{ in}^4$

$S_{3-3} = 106{,}286/66 = 1{,}610 \text{ in}^2$

△2 : 4 - ∠s 5 × 3½ × ⅜ Top & Bottom

33~34

$A = 24.2$

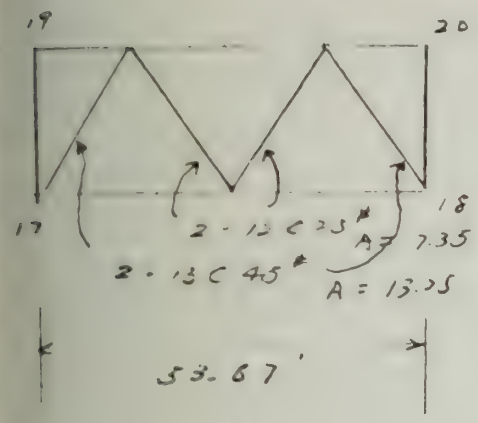
$I_{2-2} = 5490$

$S_{2-2} = 366$

$I_{3-3} = 4 \times 6.1 \times (\frac{7.5}{2} \times 12)^2 = 49{,}410 \text{ in}^4$

$S_{3-3} = 49{,}410/45 = 1{,}098 \text{ in}^3$

## Equiv Bracing



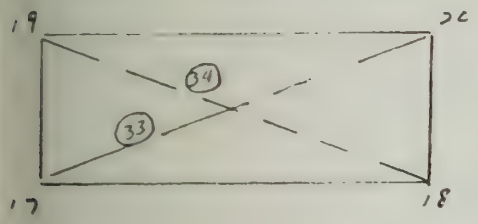

$$\ell = \sqrt{31^2 + 13.4^2} = 33.8'$$

$$\frac{P}{\delta} = \frac{AE\cos^2\theta}{\ell} \qquad \cos\theta = \frac{13.4}{33.8} = 0.4$$

$$= \frac{2 \times 13.25}{\ell}\cos^2\theta + \frac{2 \times 7.35}{\ell}\cos^2\theta$$

$$= \frac{0.16\ E}{33.8 \times 12}\left[2 \times 13.25 + 2 \times 7.35\right]$$

$$= 0.0163\ E \times 2 = 0.032\ E$$

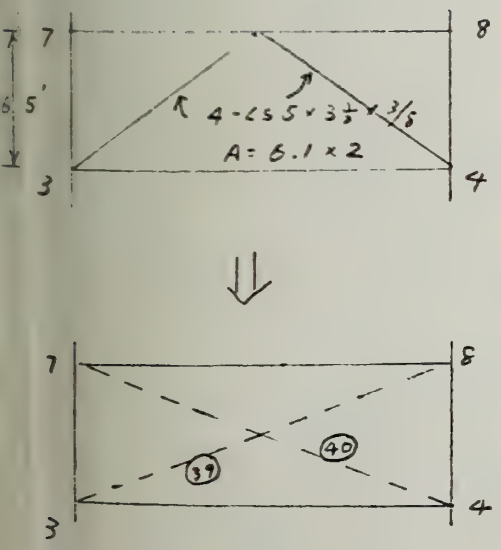



$$= \frac{2\ A'E\cos^2\theta}{\ell'} \qquad \ell = \sqrt{53.67^2 + 31^2} = 62'$$

$$0.032E = \frac{2\ AE\ (0.87)^2}{62 \times 12} \qquad \cos\theta = \frac{53.67}{62} = 0.87$$

$$A' = \frac{2 \times 0.0163 \times 62 \times 12}{2 \times (0.87)^2}$$

$$= 16.0\ in^2 \leftarrow \text{Equiv. Area}$$




$$\ell = \sqrt{26.25^2 + 26.84^2} \approx 37,$$

$$\cos\theta = 26.84/37 = 0.72$$

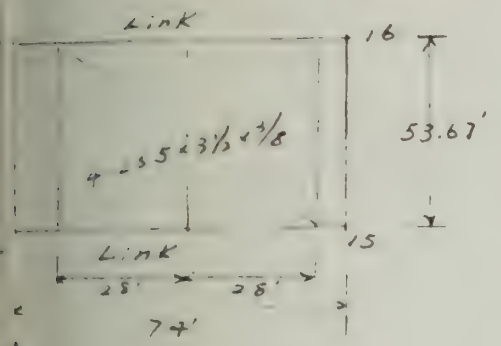
$$P/\delta = \frac{2 \times 6.1\ E}{37 \times 12} \times 0.72^2 = 0.0142\ E$$

$$0.0142\ E = \frac{2\ A'E}{\ell'}\cos^2\theta \qquad \ell' = \sqrt{26.25^2 + 53.67^2} = 59.7'$$

$$A' = \frac{0.0142 \times 59.7 \times 12}{2 \times 0.9^2} \qquad \cos\theta = 0.9$$

$$= 2 \times 6.3\ in^2 \leftarrow \text{Equiv}$$

Equiv Bracing




$A = 6.10, \quad = 12.20$

$\ell = \sqrt{28^2 + 26.8^2} = 38.8$

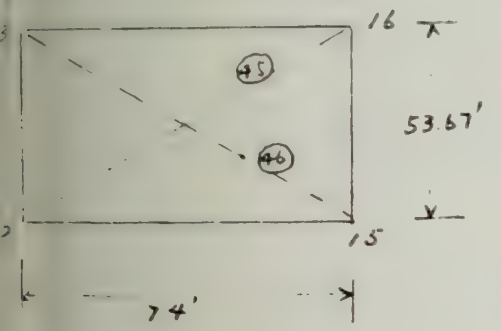
$\cos\theta = 26.8/38.8 = 0.69$

$K_1 = P/\delta =$

$= \frac{2AE}{\ell}\cos^2\theta$

$= \frac{12.2 \times 0.69^2 E}{38.8 \times 12} = 0.0125\,E$

$SK = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2}} = \frac{K}{2} = 0.00625\,E$



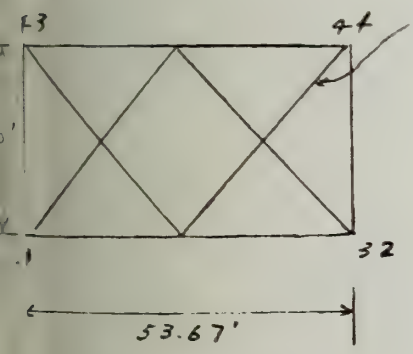

$A' = ?$

$\ell' = \sqrt{74^2 + 53.67^2} = 91.4$

$\cos\theta = 53.67/91.4$

$0.00625\,E = \frac{2A'E}{91.4 \times 12}(0.59)^2 = 0.59$

$A' = 2 \times 9.8 \text{ in}^2 \leftarrow$ Equiv.



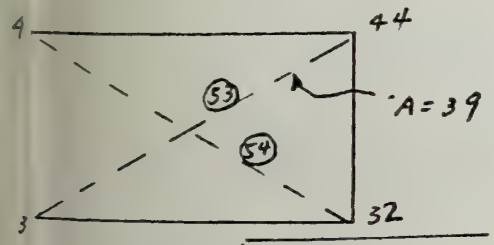

$A = 6.1,$

$\ell = \sqrt{30^2 + (\frac{53.6}{2})^2} = 40.2$

$\cos\theta = 26.8/30 = 0.89$

$P/\delta = \frac{4 \times 6.1\,E}{40.2 \times 12} \times 0.89^2 = 0.04$

$0.04\,E = \frac{2A' \times E}{\ell'}\cos^2\theta$




$A' = \frac{0.04 \times 61.4 \times 12}{2 \times 0.87^2}$

$= 2 \times 19.5 \text{ in}^2 \leftarrow$ Equiv.

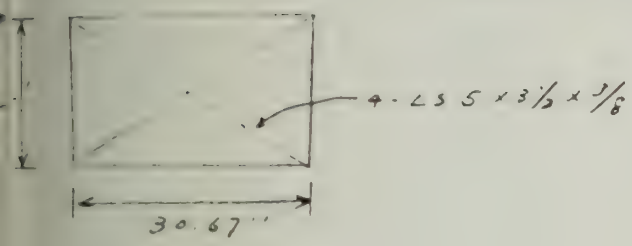
$\ell = \sqrt{53.6^2 + 30^2} = 61.4$

$\cos\theta = 53.67/61.4 = 0.87$

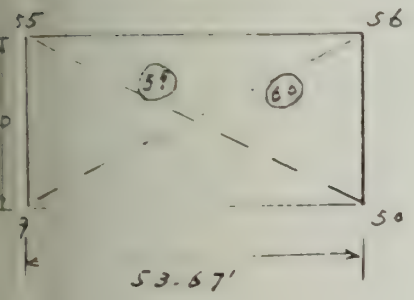
Equiv. Bracing

$A = 6.1 \times 2 = 12.2$ , $\ell = \sqrt{24^2 + 30.67^2} = 40$

$\cos\theta = 30.67/40 = 0.77$




$P/\delta = \dfrac{2 A \cos^2\theta}{\ell} = 0.030\,E$




$\ell' = \sqrt{53.67^2 + 30^2} = 61.5$

$\cos\theta = 53.67/61.5 = 0.87$

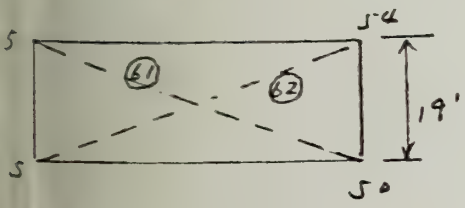
$0.030 = \dfrac{2 A' \cos^2\theta}{\ell'}$

$A' = 14.6 \text{ in}^2$ ← Equiv.

$A = 12.2$ , $\ell = \sqrt{14^2 + 30.67^2} = 33.7'$

$\cos\theta = \dfrac{30.67}{33.7} = 0.91$

$P/\delta = \dfrac{2 \times 12.2 \times E}{33.7 \times 12} \cdot \cos^2\theta = 0.05$




$0.05 = \dfrac{2 A' \cos^2\theta}{\ell'}$

$A' = 24.4 \text{ in}^2$ ← Equiv.

$\ell = \sqrt{53.67^2 + 30^2}$

$= 61.5$

$\cos\theta = 53.67/61.5$

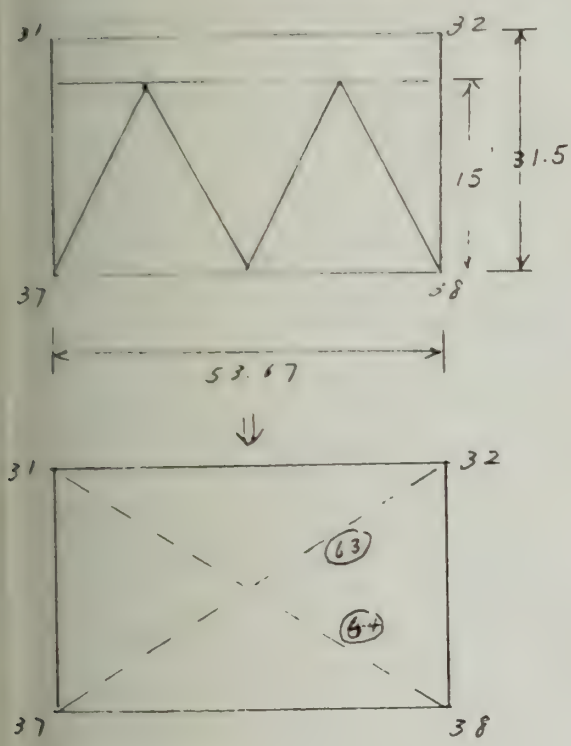
$= 0.87$

SHEET NO. 26

O. JOB S. F. Bridges BY JPC DATE 7/1/84

SUBJECT 3rd St. Bridge CHK'D DATE

Equiv. Bracing




$A = 2 - C15 \times 45$

$= 2 \times 13.25 = 26.5$

$l = \sqrt{15^2 + 13.4^2} = 20$

$\cos\theta = \frac{13.4}{20} = 0.67$

$P/\delta = \frac{4 \times 26.5 \times 0.67^2}{24.9 \times 12} = 0.159$

$l = \sqrt{31.5^2 + 53.67^2} = 62.2$, $\cos\theta = \frac{53.1}{62.2} = 0.86$

$0.159 = \frac{2A' \cos^2\theta}{l}$

$A' = 80 \text{ in}^2 \leftarrow$ equiv

spring constants @ pier # 2 - Trunnion support

pier stiffness : $\tilde{A} = \frac{14 \times 14 + 7.75 \times 7.75}{2}$

$K_p = \frac{3EI}{h^3}$ $\tilde{I} = \frac{1}{12} \times 10.87^4 = 1163 \text{ ft}^4$

$h = 31.5'$

$E_c = 29{,}000/10 = 2{,}900 \text{ ksi}$

$= \frac{3 \times 2.9 \times 10^3 \times 1163 \times (12)^4}{(31.5)^3 \times (12)^3}$

$= 3{,}884 \text{ k/in}$

pile stiffness : eff = 0.7

$K_{pile} = 22{,}176/2 = 11{,}088 \text{ k/in} \times 0.7$

$K = \frac{1}{\frac{1}{K_p} + \frac{1}{K_{pile}}} = 2{,}591 \text{ k/in}$ ... Each Trunnion support

pier # 1 :

$K_p = \frac{3 \times 2.9 \times 10^3 \times 1163 \times (12)^4}{(26.5)^3 \times (12)^3}$

$= 6524 \text{ k/in}$

$K_{pile} = 33{,}936 \times 0.7/2 = 11{,}878 \text{ k/in}$

$K = \frac{1}{.000084 + 0.000153} = 4{,}214 \text{ k/in}$ - Each CTNT support

use $K_{Longit} = K_{Trans.}$

pier # 1 328 vert. + 76 Batter

Vert. piles -

$f = 10\ T/ft^3$

$E = 226{,}800\ T/ft^2$

$I = \frac{1}{12} \times 1.67^4 = 0.65\ ft$

$T = \left(\frac{EI}{f}\right)^{0.2} = 6.8$

$K_v = \frac{f^{0.6}(EI)^{.4}}{A_s} = \frac{4.0 \times 117}{0.93}$

$= 503\ T/ft = 84\ k/in$ ... vert. pile

Batter piles -

$K_B \cong 1.25 \times 84 = 105\ k/in$

$\sim 0.75 \times 84 = 63\ k/in$

Total -

Longit $K = 404 \times 84 = 33{,}936\ k/in$

Trans. $K = 33{,}936$

pier # 2 2x88 vert. + 2x44 Batter

Longit. $K = 264 \times 84 = 22{,}176\ k/in$

Trans. $K = 22{,}176\ k/in$

use Group eff = 0.7

| Member* I.D. | Nodal* Point | A ($in^2$) | $F_a$ (Ksi) | Dead plus Seismic** $f_a$ (Ksi) | Dead plus Seismic** $\frac{f_a}{1.7\,F_a}$ | Section | |
|---|---|---|---|---|---|---|---|
| 3 | 3 - 9 | 23.4 | 11.7 | 17.7 | 0.89 | 2-C15 x 40 | |
| 7 | 9 -11 | 31.4 | 18.0 | 16.5 | 0.58 | 4-L4 x 4 x 3/8, 2-PL 20 x 1/2 | Bascule Truss |
| 9 | 11-13 | 29.3 | 12.7 | 18.7 | 0.87 | 2-C15 x 50 | Bascule Truss |
| 15 | 17-27 | 70.9 | 13.8 | 13.5 | 0.58 | 4-L4 x 4 x 5/8, 2-PL 20 x 1 5/16 | Bascule Truss |
| 17 | 27-35 | 55.0 | 14.1 | 11.7 | 0.49 | 4-L4 x 4 x 1/2, 2-PL 20 x 1 | CT WT Tower |
| 21 | 33-39 | 31.4 | 13.2 | 7.0 | 0.31 | Same as Member 7 | CT WT Tower |
| 25,26 | 1-6, 5-2 | 6.1 | 18.0 | 22.2 | 0.74 | 2-L5 x 3 1/2 x 3/8 | Floor Bracing |
| 29,30 | 9-14, 13-10 | 6.1 | 18.0 | 32.0 | 1.05 X | " | Floor Bracing |
| 31,32 | 13-18, 17-14 | 6.1 | 18.0 | 25.5 | 0.85 | " | Floor Bracing |
| 33,34 | 17-20, 19-18 | 7.4 | 18.0 | 26.6 | 0.89 | 2-C12 x 25 | Floor Bracing |
| 43,44 | 11-16, 15-10 | 12.2 | 18.0 | 13.8 | 0.46 | 4-L5 x 3 1/2 x 3/8 | Bascule Truss Top Bracing |
| 45,46 | 15-30, 29-16 | 12.2 | 18.0 | 24.6 | 0.82 | " | Bascule Truss Top Bracing |
| 47,48 | 29-44, 43-30 | | | | | | |
| 49,50 | 43-46, 45-44 | 11.4 | 18.0 | 20.0 | 0.68 | 4-L4 x 4 x 3/8 | CTWT Truss Bracing |
| 51,52 | 29-32, 31-30 | | | | | | |
| 53,54 | 31-44, 43-42 | 12.2 | 18.0 | 15.9 | 0.53 | 4-L5 x 3 1/2 x 3/8 | CTWT Truss Bracing |
| 55~58 | 31-46, 45-32 | 19.0 | 18.0 | 27.6 | 0.92 | 4-L6 x 4 x 1/2 | CTWT Truss Bracing |
| 61,62 | 49-46, 45-50 | 12.2 | 18.0 | 16.3 | 0.54 | 4-L5 x 3 1/2 x 3/8 | CTWT Truss Bracing |
| 63,64 | 37-32, 31-38 | 26.5 | 12.5 | 19.6 | 0.93 | 2-L15 x 45 - CTWT Tower | |

* See Figure 2 for member locations

** For the critical load combination

X Does not meet criteria

S. BRIDGE : GROUP V-1

TABLE 2

:/BLUME
.ssie Street (at New Montgomery)
rancisco, California 94105

SHEET NO. 30

JOB S. F. Bridge — BY CKC — DATE 8/14/84

SUBJECT 3rd St. Bridge - results — CHK'D — DATE

Truss Elements (revised Model 9/1/84)

| Member | A | Note | Gravity P | E.Q.-X P | E.Q.-Y P | E.Q.-Z P |
|---|---|---|---|---|---|---|
| 1 | 20.0 | Truss | 1078 | 4.4 | 12.1 (8.2) | 5.9 (4.3) |
| 2 | 22.4 | | 82.9 | 4.6 | 12.8 | 5.9 (4.3) |
| 3 | 23.4 | | -201 (198) | 213 (236) | 274 (295) | 49.7 (22.3) |
| 4 | 26.2 | | -185 | 225 | 205. | 51.6 |
| 5 | 19.8 | | - | - | - | - |
| 6 | 19.8 | | - | - | - | - |
| 7 | 31.4 | | 355 (352) | 149 (165) | 226 (254) | 58.1 (26.5) |
| 8 | 28.9 | | 300 | 178 | 185 | 59.6 |
| 9 | 29.3 | | -281 (279) | 115 (130) | 179 (209) | 45.3 |
| 10 | 26.3 | | -237 | 139 | 146 | 46.3 |
| 11 | 47.5 | | 526 | 116 | 339 | 71.9 |
| 12 | 45.0 | | 427 | 130 | 235 | 72.8 |
| 13 | 27.0 | | 207 | 73 | 77 | 24.8 |
| 14 | 27.0 | | 154 | 73 | 57 | 24.5 |
| 15 | 70.9 | | -551 (546) | 477 (508) | 405 (471) | 94.6 |
| 16 | 51.7 | | -428 | 447 | 300 | 92.3 |
| 17 | 55.0 | Trunnion Tower | -317 | 439 (449) | 272 (301) | 71.4 (50.6) |
| 18 | 43.2 | | -223 | 494 | 201 | 68.3 |
| 19 | 30.2 | | 210 | 75 | 83 | 22.0 |
| 20 | 33.4 | | 213 | 66 | 76 | 21.5 |
| 21 | 31.4 | | -139 (124) | 147 (142) | 73 (71) | 16.2 |
| 22 | 31.4 | | -146 (133) | 121 (117) | 61 (63) | 19.1 (31.2) |
| 23 | 78.1 | | -54 | 114 | 55 | 8.8 |
| 24 | 78.1 | | -51 | 96 | 44 | 12.7 |
| 25,26 | 6.1 | Floor Bracing | -3.0 (1.0) | 18.2 (19) / 16.7 | 42 (35.4) | 114 (112) / 114 |
| 27,28 | " | | -3.0 | 17.7 / 16.4 | 41 | 108 / 109 |
| 29,30 | " | | -13. (10) | 18.3 / 23.6 | 48 (53) | 24.6 (195) / 24.1 |
| 31,32 | " | | -14. | 17.1 / 26.0 | 45 (38) | 130 / 130 |
| 33,34 | 16.0 | | -28.0 | 22.3 / 37.0 (25.7) | 55 (50) | 148 / 148 |
| 35,36 | 6.1 | | +6.0 | 9.1 / 7.5 | 19 | 88.6 / 88.2 |
| 37,38 | 6.1 | | - | 25 / 17.0 | 16 | 92.1 / 92.5 |

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ncisco, California 94105

SHEET NO. 51

JOB S. F. Bridge BY CKC DATE 1/5/84

SUBJECT 3rd St. Bridge - Results CHK'D DATE

Truss Elements

| Member | A | Note | Gravity | EQ - X | EQ - Y | EQ - Z |
|---|---|---|---|---|---|---|
| | | | P | P | P | P |
| 39, 40 | 12.6 | Truss Top Bracing | 8.0 | 26.2/29.7 | 60/50 | 34.5/38.7 |
| 41, 42 | " | " | 5.0 | 31/35.4 (35.6) | 74 (74) | 14.1/15.5 (85) |
| 43, 44 | " | " | 12.0 | 35.7/42.9 | 92/86 | 99.6/97.2 |
| 45, 46 | 19.6 | Link-Bracing | 107.0 (100) | 70.8/91.6 (80.7) | 206/202 (173) | 47.3/49.3 (35.2) |
| 47, 48 | 11.4 | CTWT Bracing | 53/68 | 32.0/31.1 | 42 | 51.6/56.6 (35.3) |
| 49, 50 | 11.4 | " | 29/51 | 44.2/41.5 (37) (42) | 108/111 (74) (96) | 36.7/44.0 (66.8) |
| 51, 52 | 11.4 | " | -46/-57 | 54.1/43.0 | 116/121 | 29/29.6 |
| 53, 54 | 39.0 | " | -57/-75 (65) (80) | 36.2/42.3 | 46/70 | 268/314 (308) (355) |
| 55, 58 | 21.2 | " | -64/-64 (65) (65) | 78/71.6 (58) (75) | 114/148 76 (133) | 527/199 (542) (219) |
| 56, 57 | 16.7 | " | -60/-60 | 139/106 | 142/124 | 222/495 |
| 59 | Equiv. | | 17 | 51.1 | 127 | 22.3 |
| 60 | | | -17 | 51.1 | 127 | 22.3 |
| 61 | | | 24 (23) | 76.3 (83) | 87 (70) | 132 (161) |
| 62 | | | -24 (23) | 76.3 (83) | 87 (70) | 132 (161) |
| 63 | Equiv. | | -10 (19) | 76.4 (69) | 38 (47) | 1,463 (1590) |
| 64 | | | -18 (9) | 77.9 (66) | 30 (34) | 1,478 (1612) |
| 65 | 16.1 | Ties @ Top | -6 | 12.0 | 14 | 9.5 |
| 66 | " | | -10 | 17.0 | 20 | 2.2 |
| 67 | " | | -15 | 20.7 | 22 | 7.2 |
| 68 | 32.2 | | -71 | 32.8 | 32 | 22.2 |
| 69 | 12.2 | | -60 | 19.0 | 22 | 5.4 |
| 70 | 5.8 | | -2 | 7.0 | 7. | 7.0 |
| 71 | 12.2 | | . | 2 | - | - |
| 72 | 24.4 | | 122 | 47 | 39 | |
| 73 | ∞ | | 2 | | | |
| 74 | ∞ | | 23 | | . | |

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SHEET NO. 32

JOB S. F. Bridge BY [illegible] DATE [illegible]

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Truss Elements - (Revised Model)

3) :

$P = -198 \pm (236 + 0.67 \times 295)/2$ ($\pm 217$)

D.L. EQ X EQ Y

$= -414$ K

$f_a = 414/23.4 = 17.7$ ksi

$f_a / 1.7 F_a = 17.7/19.8 = 0.89 < 1.0$ OK

7) :

$P = 352 \pm (165 + 0.67 \times 254)/2$ ($\pm 167$)

D.L. EQ X EQ Y

$= 519$

$f_a = 519/31.4 = 16.5$

$f_a / 30 = 0.58 < 1.0$

9) :

$P = -279 \pm (130 + 0.67 \times 269)/2$ ($\pm 270$)

D.L EQ X EQ Y

$= -549$

$f_a = 549/29.3 = 18.7$ ksi ,

$f_a / 1.7 F_a = 18.7/21.5 = 0.87 < 1.0$ OK

5) :

$P = -546 = (508 + 0.67 \times 471)/2$ ($= 411$)

D.L. EQ X EQ Y

$= -957$ K

$f_a = 957/70.9 = 13.5$ ksi ,

$f_a / 1.7 F_a = 13.7/23.5 = 0.57 < 1.0$

(1 :

$P = -317 \pm (449 + 0.67 \times 301)/2$ ($\pm 325$)

D.L EQ X EQ Y

$= -642$ K

$f_a = 642/55 = 11.7$ ksi

$f_a / 1.7 F_a = 11.7/24 = 0.49 < 1.0$

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SHEET NO. 33

JOB

BY CHC DATE 9/2/54

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Truss Elements (Revised Model)

(21) : $P = -124 \pm (142 + 0.67 \times 71)/2 = 95$
D.L. EQX EQY

$= -219$ K

$f_a = 7.0$ ksi

$f_a / 1.7 F_a = 7.0 / 27.4 = 0.31 < 1.0$

(25)/(35) : $P = 2(112 + 0.67 \times 35.4)/2$
EQZ EQY

$= 135$ K - Tension in action only

$f_a = 135/6.1 = 22.2$ ksi

$22.2/30 = 0.74 < 1.0$

(3)/(33) : $P = [-10 \pm (195 + 0.67 \times 53)/2] \times 2$
D.L. EQZ EQY

$= 220$ K

$f_a = 220/6.1 = 36$

$36/30 = 1.2 > 1.0$ N.G.

or use $P = 2 \times 195/2 = 195$

$f_a = 195/6.1 = 32$ ksi

$f_a/30 = 1.05 > 1.0$

(1)/(32) : $P = 130 + 0.67 \times 38 = 155$

$f_a = 155/6.1 = 25.5$ ksi

$25.5/30 = 0.85 < 1.0$ O.K

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ancisco, California 94105

SHEET NO. 34

JOB

BY C.KC DATE 7/5/94

SUBJECT 3rd St. Bridge - Stress Analysis

CHK'D DATE

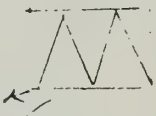
Truss 2 Element (Revised Model)

3/(8) : Equiv. sys. A = 16

$P = 2(146 + 0.67 \times 50)/2 = 90^K$
EQ Z EQ Y

$P_H = 90 \times \cos\theta = 90 \times 0.87 = 78.3^K$ .. Horiz.

Actual syst.



$P' = 78.3/\cos\theta = 78.3/0.4 = 196^K/2$

$f_a = 196/7.35 = 26.6$ ksi $/_{5.5} = 0.48 < 1.0$ o.k.
0.45

3/(8) : $P = 2(89 + 0.67 \times 14)/2$
$= 98.4$

$f_a = 98.4/6.1 = 16.1$ ksi $/_{30} = 0.54 < 1.0$ o.k.

3/(4) : Equiv. syst - A = 12.6

$P = 2(85.2 + 0.67 \times 74)/2$
$= 135^K$

$P_H = 135 \cdot \cos\theta = 135 \times 0.9 = 121^K$ .. Horiz

Actual sy. · A = 12.2

$P' = 121/0.72 = 168^K$

$f_a = 168/12.2 = 13.8/30 = 0.46 < 1.0$ o.K

3/(4) - Equiv. - A = 19.6

$P_H = 2[100 + (35.2 + 0.67 \times 173)/2]\cos\theta$
$\cos\theta = 0.59$

$= 207^K$

Actual - A = 12.2

$P' = 207/0.69 = 300$

$f_a = 300/12.2 = 24.6$ ksi
$24.6/30 = 0.82 < 1.0$ o.K

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SHEET NO. 35

JOB

BY CKC DATE 9/2/84

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Truss Elements (Revised Model)

(29)/(50) :

$P = 2[51 + (66.4 + 0.67 \times 96)/2]$

$= 233^K$

$f_a = 233/11.4 = 20$ ksi

$20/30 = 0.68 < 1.0$ O.K

(1)/(54) : Equiv. Sys.

$P_H = 2[355 + 0.67 \times 62]/2 \cdot \cos\theta$ ($\cos\theta = 0.87$)

$= 345^K$

Actual -

$P' = 345/\cos\theta$ ($\cos\theta = 0.89$) $= 388^K$

$f_a = \frac{388}{2}/12.2 = 15.9$ ksi

$15.9/30 = 0.53 < 1.0$ O.K

(5)-(58) : For (57) & (55)

$P = (542 + 0.67 \times 76 + 508 + 0.67 \times 118)/2$

$= 525^K$

$A = (16.7 + 21.2)/2 = 19.0$

$f_a = 525/19 = 27.6$ ksi $/30 = 0.92$ O.K.

(1)/(62) : Equiv.

$P_H = 2(161 + 0.67 \times 70)/2 \cdot \cos\theta$ ($\cos\theta = 0.87$) $= 181^K$

Actual -

$P' = 181/\cos\theta$ ($\cos\theta = 0.91$) $= 199^K$

$f_a = 199/12.2 = 16.3$ ksi $/30 = 0.54$ O.K

Truss Elements (Revised Model)

(63)/(64) : Tension in action -

Equiv. -

$P_H = 2(1612 + 0.67 \times 24)/2 \cdot \cos\theta$ ($\cos\theta \to 0.86$)

$= 1{,}400^K$

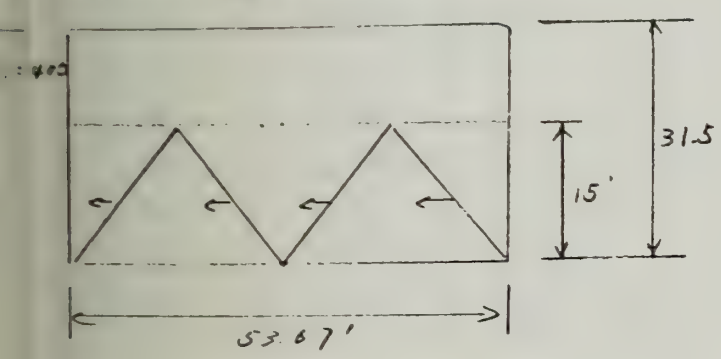
Actual -

$P = \frac{1400}{2} / \cos\theta$ ($\cos\theta \to 0.67$)

$= 1{,}044^K$

$f_a = 1044/26.5 = 39.4$ ksi $/30 = 1.3 > 1.0$ N.G.

Actual system -




$\cos\theta = \frac{15}{22} = 0.67$

Axial Force per bracing -

$= \frac{1400}{4} \cdot / 0.67$

$= 522^K$ Tension & comp.

Compression capacity -

2 - C15 x 45#, $F_a \cong 22$ ksi

$A = 26.5$

$P_{cap} = 22 \times 26.5 = 583$

$> 522^K$ o.K.

$\frac{P}{P_{cap}} = .90$

Results of Seismic Evaluation - 3rd Street over Channel (Beam Elements)

| Member* I.D. | Nodal* Point | Dead plus Seismic** | | | | |
|---|---|---|---|---|---|---|
| | | $f_a$ (Ksi) | $f_b$ (Ksi) | $\frac{f_a}{1.7F_a}$ | $\frac{f_b}{1.7F_b}$ | $\frac{f_a}{1.7F_a} + \frac{f_b}{1.7F_b}$ |
| 1 | 1- 3 | 7.2 | 13.4 | 0.24 | 0.45 | 0.69 |
| 7 | 3- 7 | 11.0 | 6.2 | 0.37 | 0.20 | 0.57 |
| 11 | 9-13 | 16.7 | 1.8 | 0.61 | 0.06 | 0.67 |
| 13 | 11-15 | 19.3 | 11.3 | 0.64 | 0.38 | 1.02 x |
| 14 | 12-16 | 17.0 | 12.7 | 0.57 | 0.42 | 0.99 |
| 15 | 13-17 | 16.8 | 1.2 | 0.62 | 0.04 | 0.66 |
| 18 | 18-20 | 9.4 | 0.9 | 0.40 | 0.03 | 0.43 |
| 21 | 15-27 | 4.7 | 20.0 | 0.20 | 0.67 | 0.87 |
| 22 | 16-28 | 2.8 | 20.5 | 0.11 | 0.68 | 0.79 |
| 23 | 23-27 | 2.9 | 20.3 | 0.10 | 0.68 | 0.78 |
| 25 | 23-33 | 19.3 | 6.5 | 0.72 | 0.21 | 0.93 |
| 29 | 37-39 | 8.3 | 19.6 | 0.29 | 0.65 | 0.94 |
| 37 | 15-29 | 13.0 | 6.3 | 0.43 | 0.21 | 0.64 |
| 39 | 29-31 | 12.7 | 8.5 | 0.50 | 0.28 | 0.78 |
| 42 | 30-44 | 16.7 | 4.3 | 0.56 | 0.14 | 0.70 |
| 43 | 31-43 | 16.4 | 14.0 | 0.61 | 0.46 | 1.07 x |
| 44 | 32-44 | 13.2 | 13.7 | 0.49 | 0.46 | 0.95 |
| 45 | 43-45 | 13.4 | 3.5 | 0.44 | 0.12 | 0.56 |
| 48 | 44-56 | 13.5 | 11.1 | 0.45 | 0.37 | 0.82 |
| 51 | 31-45 | 13.5 | 10.5 | 0.47 | 0.35 | 0.82 |

* See Figure 2 for member locations

** For the critical load combination

x Does not meet criteria

S.F. BRIDGE : GROUP V-1 TABLE 3

S/BLUME
ssie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. [illegible]

NO. JOB S. F. Bridge BY CKC DATE 8/3/84

SUBJECT 3rd St. Bridge - Computer CHK'D DATE

outputs - Y - Dir.

Beam Elements (2) Revised Model 9/3/84

| Member | Note | Gravity P | Gravity $V_{2-2}/V_{3-3}$ | Gravity $M_{2-2}$ | Gravity $M_{3-3}$ | EQ-Y P | EQ-Y $V_{2-2}/V_{3-3}$ | EQ-Y $M_{2-2}$ | EQ-Y $M_{3-3}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Truss | 64.8 (62.8) | | 93.7 (91.7) | 215 (230) | 322 (337) | 144/ | 83 | 7,[illegible]2 (5845) |
| 2 | | 79.7 | | 73.8 | 256 | 229 | 167/ | 60 | 8,535 |
| 3 | | -39.9 | | 174.2 | - | 188 | | 23 | 71 |
| 4 | | -49.9 | | 105.9 | - | 133 | | 29 | [illegible]4 |
| 5 | | -41.3 | | 174.0 | - | 178 | | 274 | 374 |
| 6 | | -46.8 | | 106.0 | - | 126 | | 138 | 334 |
| 7 | | 161.5 (159.1) | | 93.7 | 133.0 (108) | 376 (397) | | 83 (243) | [illegible] (2831) |
| 8 | | 159.6 | | 73.8 | 158.2 | 239 | | 1,458 | 5,[illegible] |
| 9 | | 163.4 | | 93.0 | 30.0 | 356 | | 293 | 600 |
| 10 | | 160.0 | | 91.2 | 85.6 | 266 | | 215 | 805 |
| 11 | | -381.4 (376.3) | | 485.6 (482) | - | 417 (466) | | 368 (434) | 374 (1274) |
| 12 | | -340.0 | | 352.3 | - | 322 | | 246 | 4,[illegible]0 |
| 13 | | 380.0 | | 194.0 (282) | 113.0 (195) | 403 (444) | | 614 (628) | 4,155 (2353) |
| 14 | | 341.6 (340) | | 120.0 (195) | 316.0 (460) | 328 (336) | | 397 (486) | 4,939 (3048) |
| 15 | | -706.6 | | 485.6 | 16.4 | 502 | | 368 | 605 |
| 16 | | -601.3 | | 352.3 | 33.0 | 404 | | 247 | 523 |
| 17 | | -155.8 | | 119.6 | 16.4 | 105 | | 189 | 530 |
| 18 | | -169.5 (168) | | 183.6 (182) | 33.0 (31.0) | 104 (100) | | 184 (253) | 482 (419) |
| 1 | | 2.0 | | 922.2 (977) | 192.9 (555) | 316 (315) | | 667 (928) | 7,279 (5654) |
| 2 | | 2.2 (20) | | 866.3 (894) | 545.1 (707) | 260 (290) | | 741 (915) | 9,345 (7379) |
| 3 | Trunnion Support | 74.9 (73.2) | 404 (398) | 15090 (14,900) | 393.8 (378) | 250 (270) | 173 (194) | 6,692 (7345) | 997 (844) |
| 4 | " | 73.7 | 371 | 14,170 | 169.8 | 199 | 167 | 6,599 | 1,010 |
| 5 | Tower Truss | -1,247 (1228) | | 1,584 (1638) | 255.9 (155) | 579 (570) | | 1,007 (976) | 378 (712) |
| 6 | | -1,013 | | 1,309 | 286.1 | 511 | | 768 | 383 |
| 7 | | -1,009 | | 4,828 | 492 | 533 | | 2,730 | 9,144 |
| 8 | | -776 | | 3,780 | 431 | 472 | | 1,919 | 601 |
| 9 | | -1,781 (1804) | | 3,293 (4933) | 1,252 (1601) | 589 (596) | 166/ (206) | 327 (3157) | 3,346 (14,155) |
| 0 | | -1,571 | | 3,227 | 606 | 339 | 162/ | 252 | 3,297 |
| 1 | | -1,627 | | 12,500 | 1,802 | 579 | | 6,954 | 1,469 |
| 2 | | -1,412 | | 11,540 | 1,076 | 335 | | 6,038 | 1,[illegible] |
| 3 | | 313 | | 649 | - | 164 | | 213 | 214 |
| 5 | | 5 | | 649 | - | 187 | | | |

/BLUME
asie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 37

JOB S. F. Bridges BY CKC DATE 8/15/2

SUBJECT 3rd St. Bridge CHK'D DATE

Computer Outputs - Y-Dir.

| Member | Note | Gravity P | Gravity $V_{2-2}/V_{3-3}$ | Gravity $M_{2-2}$ | Gravity $M_{3-3}$ | E.Q. Y P | E.Q. Y $V_{2-2}/V_{3-3}$ | E.Q. Y $M_{2-2}$ | E.Q. Y $M_{3-3}$ |
|---|---|---|---|---|---|---|---|---|---|
| 37 | L.W.K | 930 | | 7,540 (8083) | 72 (53) | 389 (446) | | 5,149 (6144) | 363 (446) |
| 38 | " | 763 | | 6,402 | 19 | 276 | | 4,076 | 329 |
| 39 | CTWT Truss | -1301 (1299) | | 4,605 (5384) | 2393 (2012) | 527 (556) | | 3621 (4661) | 5967 (4854) |
| 40 | | -1080 | | 3,744 | 2,453 | 367 | | 2,682 | 4,658 |
| 41 | | +1737 | | 2,935 | 940 | 708 | | 1,720 | 1,829 |
| 42 | | +1434 (1425) | | 2,458 (2406) | 1622 (923) | 541 (617) | | 1400 (1441) | 1676 (1584) |
| 43 | | -1147 (1143) | | 4,844 (5755) | 2,348 (2218) | 377 (350) | | 2,368 (3157) | 1,444 (1097) |
| 44 | | -947 (937) | | 4881 (5739) | 2,544 (2100) | 281 (287) | | 2,310 (3109) | 2,132 (2042) |
| 45 | | +964 (962) | | 1,539 | 815 | 609 | | 1,012 | 7,436 |
| 46 | | +780 (776) | | 1,345 (1527) | 655 (507) | 438 (492) | | 717 (929) | 4480 (3448) |
| 47 | | 715 | | 2,953 | 1,027 | 318 | 186/ | 1,381 | 13,760 |
| 48 | | 589 (586) | | 2,771 (2783) | 1214 (920) | 212 (178) | 143/ | 2,405 (2560) | 15590 (12520) |
| 51 | | -1268 (1265) | | 8,334 (9603) | 1,153 (1301) | 663 (759) | | 3985 (5211) | 3814 (1715) |
| 52 | | -1007 | | 6,889 | 1064 182 (T) | 478 | | 3158 5223 (T) | 2552 416 (T) |
| 63 | Trunnion Support | -1004 | /114 | 11570 (T) 8,154 (B) | 247 (B) | 341 | 11.1/237 | 8,725 (B) | 665 (B) |
| 64 | " | -821 | /84.9 | 10320 (T) 7,771 (B) | 97 | 323 | 11.1/207 | 7646 | 656 |
| 65 | CTWT Support | -1,996 | /76.9 | 2,520 | 444 | 605 | 29.7/224 | 6,748 | 2,552 |
| 66 | " | -1,797 | /102 | 2,745 | 173 | 338 | 29.4/189 | 5,743 | 2,510 |
| 67 | Floor Beam | | | | | | | | |
| 5 | | | | | | | | | |
| 7 | | (5.5) | | (184) | (4.9) | (10.3) | | (1654) | (864) |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 0 | | (55.5) | | (43.5) | (695) | (26.9) | | (3390) | (1244) |
| 1 | | (106) | | (34) | (641) | (38) | | (225) | (2668) |
| 2 | | | | (33) | (272) | | | (121) | (971) |

/BLUME

ssie Street (at New Montgomery)

ancisco, California 94105

SHEET NO. 40

JOB S. F. Bridge BY CKC DATE 8/15/84

SUBJECT 3rd St. Bridge - Results CHK'D DATE

Beam Elements - X- & Z-Dir

| Member | Note | E Q - X (Longit.) | | | | E.Q. - Z (Trans.) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ | P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ |
| 1 | Truss | 242 (207) | | 68 (72) | 2,721 (2583) | 47 (34) | | 50. (46) | 17,020 (14,300) |
| 2 | | 245 | | 62 | 3,155 | 49 | | 55 | 19,150 |
| 3 | | 144 | | 22 | 17 | 45 | | 44 | 79 |
| 4 | | 149 | | 32 | 18 | 42 | | 43 | 39 |
| 5 | | 142 | | 119 | 112 | 138 | | 27 | 1,508 |
| 6 | | 149 | | 51 | 104 | 135 | | 29 | 1,382 |
| 7 | | 262 (290) | | 215 (223) | 1,678 (1359) | 48 (30) | | 50 | 10,500 (16,407) |
| 8 | | 262 | | 166 | 1,946 | 49 | | 55 | 12,240 |
| 9 | | 267 | | 215 | 275 | 39 | | 50 | 3,501 |
| 10 | | 255 | | 166 | 304 | 41 | | 58 | 4,271 |
| 11 | | 408 (440) | | 328 (359) | 222 (260) | 170 (161) | | 82 | 2,174 (2,152) |
| 12 | | 433 | | 293 | 177 | 164 | | 89 | 1,854 |
| 13 | | 352 (385) | | 661 (567) | 1,513 (1047) | 108 (75) | | 132 | 18,590 (11,290) |
| 14 | | 346 (365) | | 563 (479) | 1,792 (1307) | 108 (75) | | 174 | 22,490 (14,190) |
| 15 | | 500 (533) | | 328 (359) | 252 (286) | 117 (94) | | 82 | 2,368 (2,344) |
| 16 | | 534 | | 293 | 209 | 113 | | 92 | 1,596 |
| 17 | | 59 | | 335 | 132 | 22 | | 119 | 562 |
| 18 | | 91 (90) | | 397 (410) | 262 (278) | 21 (35) | | 140 (120) | 1,548 (1,529) |
| 19 | | 212 (232) | | 442 (522) | 2,646 (2466) | 81 (54) | 104/ (84) | 189 (137) | 31,200 (24,540) |
| 20 | | 193 (211) | | 771 (839) | 3,377 (3158) | 80 (75) | 130/ (104) | 280 (205) | 39,800 (31,400) |
| 21 | Trunnion Support | 275 (295) | /113 | 5,995 (5963) | 639 (669) | 75 (56) | 181/ (160) 107 | 4479 (4661) | 8,403 (7154) |
| 22 | " | 255 | /97 | 5,142 | 579 | 75 | 186/111 | 4,693 | 8,618 |
| 23 | Tower Truss | 1,629 (1614) | | 2,579 (2177) | 180 (569) | 571 (627) | | 241 (302) | 7,019 (23,770) |
| 24 | " | 1,291 | | 1,871 | 207 | 574 | | 300 | 5,865 |
| 25 | | 1,586 | | 2,311 | 448 | 580 | | 442 | 14,230 |
| 26 | | 1,255 | | 1,379 | 288 | 580 | | 454 | 11,540 |
| 27 | | 1,679 (1656) | | 4,925 (5337) | 1,492 (2275) | 1,215 (1406) | 911/ (987) | 475 (1213) | 127,100 (202,900) |
| 30 | | 1,382 | | 4,210 | 1,400 | 1,218 | 915/ | 614 | 127,200 |
| 3 | | 1,027 | | 6,806 | 1,360 | 520 | 492/ | 475 | 127,100 |
| 3 | | 1,334 | | 5,156 | 889 | 516 | 493/ | 613 | 127,200 |
| 3 | | 169 | | 471 | 96 | 87 | | 175 | 2,203 |
| 3 | | 602 | | 471 | 96 | 83 | | | |

/BLUME
asie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 41

JOB S.F. Bridge BY CKC DATE 5/.x/8x

SUBJECT 3rd St. Bridge - Results CHK'D DATE

Beam Elements - X & Z - Dir.

| amber | Note | E.Q. X (Longit) P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ | E.Q. Z (Trans) P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ |
|---|---|---|---|---|---|---|---|---|---|
| 37 | Link | 263 (288) | | 3447 (3243) | 147 (157) | 144 (121) | | 888 (1447) | 2,520 (1405) |
| 38 | " | 268 | | 2,435 | 171 | 145 (123) | | 1,113 (1711) | 2,996 (1792) |
| 39 | CTWT Truss | 346 (361) | | 4445 (4306) | 2318 (2341) | 117 (113) | | 669 (1131) | 17190 (17,550) |
| 40 | | 319 | | 3,157 | 1,808 | 118 | | 863 | 11,810 |
| 41 | | 433 | | 612 | 876 | 157 | | 364 | 5793 |
| 42 | | 372 (400) | | 449 (682) | 750 | 156 (199) | | 352 (595) | 4815 (5859) |
| 43 | | 684 (667) | | 1,806 (1890) | 1072 (841) | 123 (113) | | 264 (832) | 10,640 (13,450) |
| 44 | | 505 (494) | | 1470 (1562) | 933 (891) | 98 (88) | | 121 (882) | 6308 (8155) |
| 45 | | 391 | | 1,512 | 2,960 | 163 (177) | | 367 (496) | 12800 (13,550) |
| 46 | | 227 | | 1,079 | 1,825 | 168 | | 416 | 8,295 |
| 47 | | 806 | | 1,677 | 8,514 | 65 | | 695 | 42880 (45520) |
| 48 | | 564 (595) | | 1176 (1180) | 5888 (5627) | 71 (81) | | 845 (920) | 32410 (33,320) |
| 1 | | 1101 (1106) | | 2,962 (3095) | 1457 (856) | 239 (253) | | 689 (856) | 5010 (5541) |
| 2 | | 762 | | 1,987 | 1,058 | 227 | | 765 | 2,705 |
| 3 | Trunnion Support | 1469 | /870 | 20,920 (T) 5,995 (B) | 638 (T) 189 (B) | 486 | 216/226 | 3,131 (T) 4189 (B) | 2,418 (T) 8,548 (B) |
| 4 | " | 1202 | /751 | 19,410 (T) 4,250 (B) | 549 (T) 180 (B) | 488 | 217/229 | 3266 (T) 4227 (B) | 2,566 (T) 8688 (B) |
| 5 | CTWT Support | 1,772 | /692 | 20750 (T) 238 (B) | 1255 (T) 896 (B) | 1,485 | 910/155 | 605 (T) 5,202 (B) | 100,000 (T) 127,300 (B) |
| 6 | " | 1,460 | /606 | 18,320 (T) 183 (B) | 1222 (T) 945 (B) | 1486 | 910/155 | 658 (T) 5,249 (B) | 100,000 127,300 |
| 7 | Truss Ties | | | | | (8.1) | | (768) | (2562) |
| 8 | " | | | | | (1.7) | | (881) | (741) |
| 9 | " | | | | | (6.4) | | (1170) | (843) |
| 0 | " | (27) | | (1507) | (538) | (15) | | (1158) | (4933) |
| 1 | CTWT Tower Ties | (42) | | (207) | (1490) | (9.1) | | (1138) | (4738) |
| 2 | | | | | | (1.2) | | (4,665) | (28,670) |

URS/BLUME

130 Jessie Street (at New Montgomer
San Francisco, California 94105

JOB NO. _____ JOB _____

CLIENT _____ SUBJECT 3r

△ : $P = 62.8$

$0.L$

$= 227$

$f_P = 227$

$= 101$

$M_{3-3} = 23$

$0.$

$= 63$

$f_{3-3} = 63$

$\frac{7.2}{30}$

△ : $P = 159.1$

$0.L$

$= 344$

$f_P = 344$

$M_{3-3} = 15$

$0.L$

$= 29$

$f_{3-3} = 29$

$\frac{11}{3}$

Beam Elements (Revised Model)

△ :

$$P = -376.3 = (\overset{3251}{440} + 0.67 \times 466)/2$$

D.L. EQ X EQ Y

$= -627$

$f_P = 627/37.5 = 16.7$ KSI

$$M_{3-3} = 0 + (2151 + 0.67 \times 1274)/2$$

EQ. Z EQ Y

$= 1001$ K-in

$f_{3-3} = 1001/562 = 1.8$

$$\frac{16.7}{1.7 \times 16} + \frac{1.8}{30} = 0.62 < 1.0 \quad \text{O.K.}$$

△ :

$$P = 380 \pm (385 + 0.67 \times 444)/2$$

EQ X EQ Y

$= 607$

$f_P = 607/31.44 = 19.3$ KSI

$$M_{3-3} = 1047 + (11{,}290 + 0.67 \times 2353)/2$$

EQ Z EQ Y

$= 5335$

$f_{3-3} = 5335/472 = 11.3$

$$\frac{19.3 + 11.3}{30} = 30.6/30 = 1.02 \quad \text{O.K.}$$

S'BLUME
...ale Street (at New Montgomery)
Francisco, California 94105

SHEET NO. A-4

JOB

BY CKC DATE 9/5/84

SUBJECT 3rd St. Bridge - stress Analysis CHK'D DATE

Beam Elements (Revised Model)

(2) :

$P = 340 \pm (365 + 0.67 \times 336)/Z$

EQ X EQ Y

$= 536$

$f_p = 536/31.44 = 17.0$ ksi

$M_{3-3} = 460 + (14{,}190 + 0.67 \times 3648)/Z$

EQ Z EQ Y

$= 6005$ k-in

$f_{3-3} = 6005/472 = 12.7$

$\frac{17 + 12.7}{30} = 29.7/30 = 0.99$ o.k.

(3) :

$P = -700 \pm (533 + 0.67 \times 583)/Z$ (308)

EQ. X + EQ. Z

$= -1008$ k

$f_p = 1008/60 = 16.8$

$M_{3-3} = (2344 + 0.67 \times 1253)/Z$

$= 1062$

$f_{3-3} = 1062/900 = 1.18$

$\frac{16.8}{1.7 \times 16} + \frac{1.18}{30} = 0.62 < 1.0$ o.k.

(8) :

$P = -168 \pm (90 + 0.67 \times 100)/Z$

$= -220$

$f_p = 220/23.6 = 9.4$ ksi

$M_{3-3} = (1529 + 0.67 \times 419)/Z$

$= 603$

$f_{3-3} = 603/684 = 0.88$

$9.4/1.7 \times 13.8 + 0.88/30 = 0.41 < 1.0.$

Beam Elements (Revised Model)

51 :

$P = (232 + 0.67 \times 315)/2$
EQ X + EQ Y
$= 147$

$f_p = 147/31.4 = -4.7$ KSI

$M_{3-3} = 56 + (24{,}640 + 0.67 \times 5654)/2$
EQ. Z EQ. Y
$= 9532$ K-in

$f_{3-3} = 9532/477 = 20$ KSI

$\frac{4.7}{1.7 \times 13.9} + \frac{20}{30} = 0.2 + 0.67 = 0.87$ O.K

52 : $P = 20 \pm (211 + 0.67 \times 290)/2$ ($\pm 135$)
EQ X EQ. Y
$= -115$

$f_p = 115/41.7 = -2.8$

$M_{3-3} = 707 + (31{,}400 + 0.67 \times 7375)/2$
EQ. Z EQ Y
$= 12{,}821$ K-in

$f_{3-3} = 12{,}821/626 = 20.5$

$\frac{2.8}{1.7 \times 14.8} + \frac{20.5}{30} = 0.11 + 0.68 = 0.79 < 1.0$
O.K.

Beam Elements (Revised Model)

23 : $P = 232 \pm (295 + 0.67 \times 270)/2$
24 EQ X + EQ Y

$= 232$

$f_p = 232/79.5 = 2.9$

$M_{2-2} = 14{,}900 + (5963 + 0.67 \times 7345)/2$
EQ X EQ Y

$= 18{,}528$

$f_{2-2} = 18528/913 = 20.3$

$\frac{2.9 + 20.3}{30} = 0.77 < 1.0$ O.K

25 : $P = -1228 \pm (1572 + 0.67 \times 570)/2$ ±651
26

$= -1879$ K

$f_p = 1879/97.5 = 19.3$ ksi

$M_{3-3} = (23{,}770 + 0.67 \times 712)/2$

$= 8{,}082$ k-in

$f_{3-3} = 8082/1244 = 6.5$

$\frac{19.3}{1.7 \times 15.7} + \frac{6.5}{30} = 0.72 + 0.21 = 0.93 < 1.0$
O.K

Beam Elements (Revised Model)

$P = -1,804 \pm (1656 + 0.67 \times 596)/2$
EQX EQY

$= -2489$

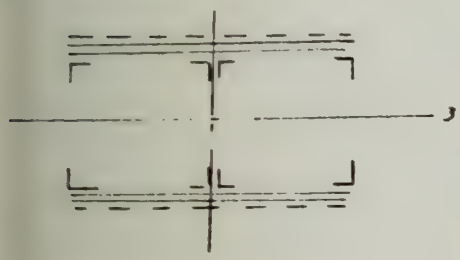
$f_P = -2489/227.9 = -10.9$ ksi

$M_{3-3} = 1601 + (204,900 + 0.67 \times 4155)/2$
EQZ + EQY

$= 70,828$

$f_{3-3} = 70828/2033 = 34.8$ ksi

@ Bottom & Top of Elements 29 / 30, additional 36" x 1 steel PL are provided as follows:




$A = 227.9 + 2 \times 36 \times 1 = 300$ in$^2$

$I_{3-3} = 39,250 + 36 \times 2 \times 13.5^2$

$= 52,372$ in$^4$

$S_{3-3} = 52372/14.5 = 3611$ in$^3$

$f_{3-3} = \dfrac{70,828}{3611} = 19.6$

$f_P = \dfrac{-2489}{300} = 8.3$

$\dfrac{8.3}{1.7 \times 16.6} + \dfrac{19.6}{30} = 0.29 + 0.65 = 0.94 < 1.0$

O.K.

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SHEET NO. 28
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BY CLC DATE 9/2/86
SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Beam Elements (Revised model)

△/38 : o.k. see orig. model, 0.64 < 1.0

△/42 : o.k stress ratio = 0.78 - orig. model.

△/43 : o.k ratio = 0.70 - orig. model

△1 :

$$P = -1143 \pm (667 + 0.67 \times 350)/2$$
D.L EQ X EQ Y

$$= -1444 \text{ K}$$

$$f_p = 1444/88 = -16.4 \text{ ksi}$$

$$M_{2-2} = 5755 + (1890 + 0.67 \times 3157)/2$$
EQ X EQ Y

$$= 7090$$

$$f_{2-2} = 7090/507 = 14.0$$

$$\frac{16.4}{1.7 \times 15.8} + \frac{14}{30} = 0.61 + 0.46 = 1.07 > 1.0$$

△4 :

$$P = -937 \pm (494 \pm 0.67 \times 287)/2$$
EQ X EQ Y

$$= -1166$$

$$f_p = 1166/88 = 13.2$$

$$M_{2-2} = 5739 + (1562 + 0.67 \times 3109)/2$$
EQ X EQ Y

$$= 6954$$

$$f_{2-2} = 6954/507 = 13.7 \text{ ksi}$$

$$13.2/1.7 \times 15.8 + 13.7/30 = 0.49 + 0.46 = 0.95$$

o.k

Beam Elements (Revised Model)

: o.k. see orig. model
stress ratio ≈ 0.56

$P = 716 + (786 + 0.67 \times 303)/2$
EQ. X EQ. Y

$= 1045$

$f_p = 1045/81.5 = 12.8$ ksi

$M_{3-3} = 971 + (45{,}520 + 0.67 \times 15{,}990)/2$
EQ Z

$= 19{,}715$

$f_{3-3} = 19{,}715/1922 = 10.3$

$\frac{12.8 + 10.3}{30} = 0.77 < 1.0$ o.k.

: $P = 556 + (545 + 0.67 \times 178)/2$
EQ X EQ Y

$= 777$

$f_p = 777/60.9 = 12.8$

$M_{3-3} = 920 + (32{,}320 + 0.67 \times 12{,}520)/2$
EQ Z EQ Y

$= 14{,}089$

$f_{3-3} = 14{,}089/1333 = 10.9$

$\frac{12.8}{30} + \frac{10.9}{30} = 0.79 < 1.0$ o.k.

Beam Elements (Revised Model)

S1 :

$$P = -1265 \pm (1106 + 0.67 \times 759)/2$$

$\pm 538$

EQ X EQ Y

$$= -1803$$

$$f_p = 1803/133.4 = 13.6$$

$$M_{2-2} = 9603 + (3095 + 0.67 \times 5211)/2$$

EQ X EQ Y

$$= 11,798$$

$$f_{2-2} = 11798/971 = 12.1$$

$$\frac{13.6}{1.7 \times 16.7} + \frac{12.1}{30} = 0.48 + 0.4 = 0.88 < 1.0$$

O.K.

S2 :

$$P = -1005 \pm (747 + 0.67 \times 527)/2$$

$\pm 367$

D.L EQ X EQ Y

$$= -1371$$

$$f_p = 1371/105.7 = 13.$$

$$M_{2-2} = 7869 + (2088 + 0.67 \times 4135)/2$$

EQ X EQ Y

$$= 9488$$

$$f_{2-2} = 9488/755 = 12.6$$

$$\frac{13}{1.7 \times 16.7} + \frac{12.6}{30} = 0.46 + 0.42 = 0.88$$

O.K

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SHEET NO. 51

JOB S. F. Bridge BY CHC DATE 5/3/84

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Truss Elements - Truss / Tower

| Member | A | 1.7Fa | combined Axial | fa | fa/1.7Fa |
|---|---|---|---|---|---|
| 1 | 20 | 30 | 107.8 ± (5.9 + 0.67×12.1)/2 = 115 | 5.7 | 0.19 |
| 2 | 22.4 | | - | | |
| 3 | 23.4 | 15.5* × 1.7/1.33 = 19.8 | -201 ± (213 + 0.67×274)/2 = -399 | 17.1 | 0.86 |
| 4 | 26.2 | | | | |
| 5 | 19.8 | | | | |
| 6 | 19.8 | | | | |
| 7 | 31.4 | 30 | 355 ± (149 + 0.67×226)/2 = 505 | 16.0 | 0.54 |
| 8 | 28.9 | | | | |
| 9 | 29.3 | 16.8* × 1.7/1.33 = 21.5 | -288 ± (115 + 0.67×179)/2 = -405 | 13.8 | 0.64 |
| 10 | 26.3 | | | | |
| 11 | 47.5 | 30 | 526 ± (116 + 0.67×339)/2 = 698 | 14.7 | 0.49 |
| 12 | 45.0 | | | | |
| 13 | 27.0 | 30 | 207 ± (73 + 0.67×77)/2 = 269 | 9.9 | 0.33 |
| 14 | 27.0 | | | | |
| 15 | 70.9 | 18.4* × 1.7/1.33 = 23.5 | -551 ± (477 + 0.67×406)/2 = -925 | 13.1 | 0.56 |
| 16 | 51.7 | 23.5 | -428 ± (447 + 0.67×300)/2 = -752 | 14.5 | 0.62 |
| 17 | 55.0 | 18.75* × 1.7/1.33 = 24.0 | -317 ± (439 + 0.67×272)/2 = -627 | 11.4 | 0.48 |
| 18 | 43.2 | | -273 ± (494 + 0.67×201)/2 = -537 | 12.4 | 0.52 |
| 19 | 30.2 | 30 | 212 ± (66 + 0.67×76)/2 = 270 | 9.0 | 0.30 |
| 20 | 33.4 | | | | |
| 21 | 31.4 | | | | |
| 22 | 31.4 | 17.5* × 1.7/1.33 = 22.4 | -146 ± (121 + 0.67×61)/2 = -227 | 7.2 | 0.32 |
| 23 | 78.1 | | -54 ± (114 + 0.67×55)/2 = -129 | 1.7 | |
| 24 | 78.1 | | | | |

* From Drawing # B-9582

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SHEET NO. 52

JOB S. F. Bridge BY CKC DATE 2/17/84

SUBJECT 3rd St. Bridge - stress CHK'D DATE

Truss Elements - Diagonal Bracing - assuming tension in action

| Member | A | Combined Axial | fa | fa/30 | Note |
|---|---|---|---|---|---|
| 25 | 6.10 | 2(114 + 0.67×42)/2 = 142 | 23.3 | 0.78 | Bracing @ Floor |
| 26 | | | | | |
| 27 | | | | | |
| 28 | | | | | |
| 29 | | | | | |
| 30 | | | | | |
| 31 | | | | | |
| 32 | 6.10 | 2(130 + 0.67×45)/2 = 160 | 26.2 | 0.87 | |
| 33 | Equiv. | see calc. | 26.8 | 0.89 | |
| 34 | | | | | |
| 37,38 | 6.10 | 2(92.5 × 0.67×16)/2 = 103 | 16.9 | 0.56 | |
| 39,40 | Equiv. | see calc. | 7.5 | 0.25 | Bracing @ Top of Truss |
| 43,44 | | | 16.2 | 0.54 | |
| 45/46 | Equiv. | see calc. | 20.4 | 0.68 | Link Brac |
| 47/48 | 11.4 | | | | |
| 49/50 | " | [31 + (44 + 0.67×111)/2]2 = 218 | 19.2 | 0.64 | CTWT Bracing |
| 51/52 | " | | | | |
| 53/54 | Equiv. | see calc. | 13.2 | 0.44 | |
| 55/58 | 21.2 | see cal. | 32.8 | 1.09 | Lateral connector |
| 56/57 | 16.7 | | | | |
| 61,62 | Equiv. | see cal. | 14.8 | 0.49 | CTWT Bracing |
| 63,64 | Equiv. | see cal. | 44.5 | 1.48 | CTWT Tower Brac |

Brace Elements

(33)/(34) . Equiv. System :

$P = (148 + 0.6 \times 55)/2 = 90.5^K$

$P_H = 90.5 \times \cos\theta = 90.5 \times 0.87 = 78.7$ -- Horiz shear

Actual system :

$P' = 78.7 \times \frac{1}{\cos\theta} = \frac{78.8}{0.4} = 197^K$ ... Axial

$f_a = 197/7.35 = 26.8$ ksi.

(39)/(40) :

Equiv. system -

$P_H = (34.5 + 0.67 \times 60)/2 + (38.7 + 0.67 \times 50)/2$

$= (37.4 + 36.1) \times \underset{0.9}{\cos\theta} = 66.2^K$ -- Horiz

Actual system -

$P' = 66.2/\cos\theta = 66.2/0.72 = 92^K$ -- Axial

$f_a = 92/12.2 = 7.5$ ksi

(3)/(44) : Equiv. -

$P_H = [(97.2 + 0.67 \times 86)/2 + (99.6 + 0.67 \times 92)/2] \cdot \cos\theta$

$= (77.4 + 80.6) \cdot 0.9 = 142^K$ ... Horiz.

Actual -

$P = 142/0.72 = 197^K$ ... Axial

$f_a = 197/12.2 = 16.2$ ksi

(5)/(46) . Equiv. -

$P_H = [107 + 2(49.3 + 0.67 \times 202)/2] \cos\theta$

$= 192 \times 0.89 = 172^K$ ..... Horiz.

Actual -

$P = 172/0.69 = 249^K$ .... Axial

$f_a = 249/12.2 = 20.4$ ksi

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SHEET NO. 54

JOB S. F. Bridge BY - PC DATE 8/27/84

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Brace Elements Tension in action only

(53)/(54) :

Equiv. -

$P_H = [(314 + 0.67 \times 70)/2 + (268 + 0.67 \times 46)/2] \cos\theta$ ($\cos\theta \approx 0.87$)

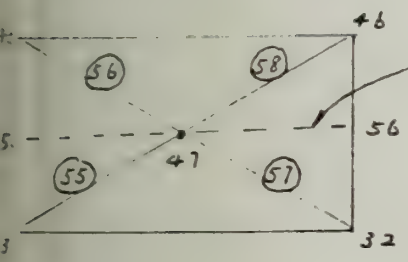
$= 287^K$ ... Horiz.

Actual -

$P = 287/\cos\theta = 322^K$ ... axial ($\cos\theta \approx 0.89$)

$f_a = 322/12.2 = 26.4/2 = 13.2$ ksi

(53) ~ (58) :




Lateral Force connector

For (57) & (55) -

$P = (592 + 0.67 \times 114 + 495 + 0.67 \times 124)/2$

$= 623$ K

$A \approx (16.7 + 21.2)/2 = 19.0$

$f_a = 32.8$ ksi

(61)/(62) : Equiv. -

$P_H = (132 + 0.67 \times 87)/2 = 95 \times 2 \times \cos\theta$ ($\cos\theta \approx 0.87$)

$= 165$ K ... Horiz.

Actual -

$P = 165/\cos\theta = 181^K$ ($\cos\theta \approx 0.91$)

$f_a = 181/12.2 = 14.8$ ksi

Truss Elements

53 / 64 :

Equiv System -

$$P_H = 2\{(1478 + 0.67 \times 30)/2\} \underset{0.86}{\cos\theta}$$

$$= 1,271^{K} \ldots \text{Horiz.}$$

Actual System -

$$P = \frac{1271}{2} / \underset{0.54}{\cos\theta} = 1,177^{K} \ldots \text{Axial}$$

$$f_a = 1177/26.5 = 44.5 \text{ ksi}$$

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SHEET NO. 55

JOB S. F. Bridge BY CKC DATE 8/11/84

SUBJECT 3rd St. Bridge - CHK'D DATE

Section properties - Beam Element

| Member No. | Mat. No. | A | $I_{2-2}$ | $I_{3-3}$ | $S_{2-2}$ | $S_{3-3}$ | $r_{min}$ | $\ell$ | $\ell/r$ | $F_a$ (KSI) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 31.44 | 1,810 | 7,074 | 181 | 472 | 7.59 | 510.8 | 67.3 | 13.9 |
| 2 | 2 | 38.24 | 2,156 | 8,604 | 216 | 574 | 7.51 | 510.8 | 68.0 | 13.9 |
| 3 | 3 | 26.44 | 1,644 | 5,949 | 164 | 397 | 7.89 | 315.0 | 40.0 | 16.0 |
| 4 | 3 | | | | " | " | | | | " |
| 5 | " | | | | " | " | | | | " |
| 6 | " | | | | " | " | | | | " |
| 7 | 1 | 31.44 | | | | | 7.59 | 315 | 41.5 | 15.9 |
| 8 | 1 | " | | | | | " | | " | " |
| 9 | 1 | " | | | | | " | | " | " |
| 0 | 1 | " | | | | | " | | " | " |
| 1 | 4 | 37.50 | 2,252 | 8,438 | 225 | 562 | 7.74 | 315 | 40.7 | 16.0 |
| 2 | 1 | | | | | | | | | 15.9 |
| 3 | 1 | | | | | | | | | 15.9 |
| 4 | 1 | | | | | | | | | " |
| 5 | 5 | 60 | 3,004 | 13,500 | 300 | 900 | 7.74 | 315 | 40.7 | 16.0 |
| 6 | 6 | 46.44 | 2,310 | 10,467 | 231 | 698 | 7.05 | 315 | 44.7 | 15.7 |
| 7 | 7 | 20.0 | 630 | 4,500 | 82 | 300 | 5.60 | 372 | 66.0 | 14.5 |
| 8 | 8 | 23.6 | 698 | 10,260 | 93 | 684 | 5.44 | 372 | 68.4 | 13.8 |
| 1 | 1 | 31.4 | | | 181 | 472 | | | | 13.9 |
| 2 | 10 | 41.7 | 2,506 | 9,387 | 251 | 626 | 7.75 | ≈511 | 65.9 | 14.8 |
| 3 | 11 | 57.5 | 6,590 | 10,143 | 573 | 483 | | | | 0.6 Fy |
| 4 | 11 | 57.5 | " | " | | | | | | " |
| 5 | 12 | 95.7 | 9,615 | 16,177 | 687 | 1,244 | 10.0 | 451 | 45.1 | 15.7 |
| 6 | 13 | 79.0 | 8,166 | 13,350 | 583 | 1,027 | 10.1 | 492 | 49.2 | 15.4 |
| 7 | 12 | 95.7 | | | 687 | 1,244 | | | | 15.7 |
| 8 | 13 | 79.0 | | | 583 | 1027 | | | | 15.4 |
| 9 | 14 | (237.88) 155.9 | (24,767) 16,790 | (39,240) 25,128 | (1376) 944 | (2,803) 1,794 | (8.63) 10.4 | (246) 318 | (28.5) 30.5 | (16.7) 16.6 |
| 0 | " | " | " | " | | | | 378 | 36.3 | 16.2 |
| 1 | " | " | " | " | | | | | | 16.6 |
| 2 | " | " | " | " | | | | | | 16.2 |
| 3 | | | | | | | | | | |
| 5 | | | | | | | | | | |

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SHEET NO. 37

JOB S. F. Bridge BY CKC DATE 8/16/84

SUBJECT 3rd St. Bridge CHK'D DATE

Section properties - Beam Elements

| mber No. | mat. No. | A | $I_{2-2}$ | $I_{3-3}$ | $S_{2-2}$ | $S_{3-3}$ | $r_{min}$ | $\ell$ | $\ell/r$ | Fa |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 18 | 84.75 | 41,847 | 2,552 | 1,550 | 255 | 5.49 | 895½ | 81 | 12.7 |
| 8 | " | " | " | " | " | " | | | | " |
| 9 | 19 | 121.0 | 12,190 | 72,663 | 812 | 2,906 | 10.0 | 558 | 55.8 | 14.8 |
| 0 | 20 | 98.0 | 9,707 | 46,328 | 647 | 2,059 | 9.95 | 558 | 56.0 | 14.8 |
| 1 | 21 | 126.4 | 13,092 | 74,300 | 873 | 2,972 | 11.24 | 612 | 54.4 | 15.0 |
| 2 | 22 | 100.7 | 10,176 | 47,440 | 678 | 2,132 | 10.0 | 612 | 61.2 | 14.4 |
| 3 | 23 | 88.0 | 6,597 | 52,037 | 507 | 2,281 | 8.65 | 381 | 44.0 | 15.8 |
| 4 | 24 | 68.9 | 6,396 | 34,946 | 492 | 1,571 | 9.63 | | 39.5 | 16.0 |
| 5 | 25 | 90.5 | 9,130 | 53,505 | 609 | 2,162 | 10.0 | 452 | 45.2 | 15.6 |
| 6 | 26 | 71.3 | 8,694 | 32,303 | 580 | 1,460 | 11.0 | | 41.0 | 15.9 |
| 7 | 27 | 81.5 | 6,233 | 48,055 | 479 | 1,922 | 8.7 | ≈240 | 28.0 | 16.7 |
| 8 | 28 | 60.9 | 5,462 | 29,467 | 420 | 1,332 | 9.5 | " | 25.3 | 16.9 |
| 1 | 29 | 132.4 | 15,532 | 77,978 | 971 | 3,119 | 10.8 | 623½ | 28.8 | 16.7 |
| 2 | 30 | 105.7 | 12,085 | 49,891 | 755 | 1,996 | 10.7 | | " | 16.7 |
| 63 | 11 | 57.5 | 6590 | 10,143 | 573 | 483 | | | | 0.6Fy |
| 64 | 11 | " | | | | | | | | " |
| 65 | 14 | 155.9 | | | 944 | 1,794 | | | | 0.6Fy |
| 66 | 14 | " | | | " | " | | | | " |

Beam Elements

$Z = 3.0$ , $f_b' = 1.7 \times 0.6 F_y = 30$ ksi
$f_p' = 30$ ksi

2 :

$P = 64.8 \pm (242 + 0.67 \times 322)/Z$
D.L. EQ. X + 153 E.Q. Y

$= 217$ kips or $-88$ kips

$f_p = 217/31.44 = 6.9$ ksi
$= -88/31.44 = -2.8$ ksi

$M_{3-3} = 215 + (17{,}020 + 0.67 \times 7352)/Z$
D.L. EQ. Z + EQ Y

$= 7530$ k-in

$f_{3-3} = 7530/472 = 15.95$ ksi ,

$$\frac{f_{3-3}}{f_b'} + \frac{f_p}{f_p'} = \frac{15.95}{30} + \frac{6.9}{30} = 0.53 + 0.23 < 1$$

$$\text{or} = 0.53 + \frac{2.8}{1.7 \times 13.9} = 0.53 + 0.12 < 1.0$$

O.K.

3 :

$P = -39.9 \pm (144 + 0.67 \times 188)/Z$
D.L. EQ. X + 90 EQ Y

$= -130$ K

$f_p = 130/26.44 = 4.9$ ksi $< 1.7 \times 16 = 27.2$ ksi

O.K.

$M_{2-3}$ & $M_{3-3}$ small.

6 :

$P = -41.3 \pm (142 + 0.67 \times 178)/Z$
D.L EQ. X + 87 EQ Y .

$= -128$

$f_p = 128/26.44 = 5.23$ ksi $< 27.2$ O.K.

Beam Elements

$\Delta$ : $P = 161.5 \pm (262 + 0.67 \times 376)/z$ (171)

D.L. EQ. X + EQ Y

$= 333$ kips

$M_{3-3} = 133 + (10{,}500 + 0.67 \times 4535)/z$ (4312)

D.L. EQ. Z + EQ. Y

$= 4{,}646$ k-in

$f_p = 333/31.44 = 10.6$ ksi

$f_{3-3} = 4646/472 = 9.8$ ksi

$\frac{f_p}{30} + \frac{f_{3-3}}{30} = 0.68 < 1.0$ o.k.

$\Delta$ : $P = -381.4 \pm (408 + 0.67 \times 417)/z$ (229)

D.L. EQ X + EQ Y

$= -610.5$ K

$M_{2-2} = 485.6 + (328 + 0.67 \times 417)/z$ (93)

D.L. EQ. X + EQ Y

$= 579$ k-in

$f_p = 610.5/37.5 = 16.28$ ksi

$f_{2-2} = 579/225 = 2.6$ ksi

$\frac{16.28}{1.7 \times 16} + \frac{2.6}{30} = 0.6 + 0.09 = 0.69 < 1.0$ o.k.

Beam Elements

4 : $P = 341.6 \pm (346 + 0.67 \times 328)/2$ (189)

D.L.

$= 530.$ K

$f_p = 530/31.44 = 16.86$ ksi

$M_{3\cdot3} = 316 + (22{,}490 + 0.67 \times 4959)/2$

D L  EQ. Z + EQ. Y

$= 8916$ K-in

$f_{3\cdot3} = 8916/472 = 18.8$ ksi

$\frac{16.86}{30} + \frac{18.8}{30} = 1.19 > 1.0$ ←

13 : $P = 380 \pm (352 + 0.67 \times 403)/2$

$= 587$ K

$f_p = 587/31.44 = 18.7$ ksi

$M_{3\cdot3} = 113 + (18{,}590 + 0.67 \times 4{,}155)/2$

D.L.  EQ Z  EQ Y

$= 7{,}238$

$f_{3\cdot3} = 7238/472 = 15.3$ ksi

$\frac{18.7 + 15.3}{30} = \frac{34}{30}$ ksi $= 1.13 > 1.0$ ←

Beam Elements

a) :

$P = -706.6 \pm (500 + 0.67 \times 502)/2$ (379)

D.L. E.Q.X E.Q.Y

$= -986$ K

$f_p = 986/60 = -16.4$ ksi

$M_{3-3} = 16.4 + (2368 + 0.67 \times 805)/2$

D.L. E.Q.Z E.Q.Y

$= 941$ K-in

$f_{3-3} = 941/900 = 1.0$ - small

$16.4/16.6 \times 1.7 = 0.6 < 1.0$ O.K.

b) : $P = -169.5 \pm (91 + 0.67 \times 104)/2$ (53.6)

D.L. E.Q.X. E.Q.Y

$= -223$ K

$f_p = 223/23.6 = 9.45$ ksi

$M_{3-3} = 33 + (1548 + 0.67 \times 482)/2$

D.L. E.Q.Z + E.Q.Y

$= 656$ K-in

$f_{3-3} = 656/684 = 0.96$

$9.45/13.8 \times 1.7 + 0.96/30 = 0.4 + 0.032 < 1.0$

O.K.

Beam Elements

51 :

$$P = 2.0 \pm (212 + 0.67 \times 316)/2$$
$$\text{EQ X} + \text{EQ Y}$$
$$= -132 \text{ K}$$

$$f_p = -132/31.4 = -4.20 \text{ ksi}$$

$$M_{3-3} = 192.9 + (31{,}200 + 0.67 \times 72779)/2$$
$$\text{D.L.} \qquad \text{EQ Z} + \text{EQ Y}$$
$$= 12{,}219 \text{ K-in}$$

$$f_{3-3} = 12{,}219/477 = 25.6 \text{ ksi}$$

$$\frac{4.20}{1.7 \times 13.9} + \frac{25.6}{30.0} = 0.18 + 0.85 = 1.03 > 1.0$$

Say O.K.

52 :

$$P = 2.0 \pm (193 + 0.67 \times 260)/2$$
$$\text{D.L} \qquad \text{EQ.X} \qquad \text{EQ.Y}$$
$$= -120 \text{ K}$$

$$f_p = 120/41.7 = 2.9 \text{ ksi}$$

$$M_{3-3} = 545 + (33{,}800 + 0.67 \times 9345)/2$$
$$\text{D.L.} \qquad \text{E.Q.Z} \qquad \text{E.Q.Y}$$
$$= 15{,}898 \text{ K-in}$$

$$f_{3-3} = 15898/626 = 25.4 \text{ ksi}$$

$$\frac{2.9}{14.8 \times 1.7} + \frac{25.4}{30.0} = 0.11 + 0.85 = 0.96 < 1.0$$

O.K.

Beam Elements

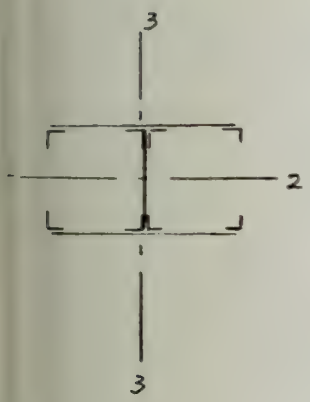
$P = 74.9 + (275 + 0.67 \times 250)/2$
D.L. EQ. X EQ. Y
$= 222$ kip

$f_P = 222/57.5 = 3.9$ ksi

$M_{2-2} = 15{,}090 + (5995 + 0.67 \times 6692)/2$
$= 18{,}583$ k-in

$f_{2-2} = 18{,}583/573 = 32.4$ ksi

$\frac{3.9}{30} + \frac{32.4}{30} = 1.2 > 1.0$ ←




8 - ∠s 6 × 6 × 1/2 $A = 5.75$, $\bar{x} = \bar{y} = 1.68$
1 web PL 23 × 1/2
2 cover PLs 42 × 1/2

$\Sigma A = 8 \times 5.75 + 11.5 + 22 = 79.5$

$I_{2-2} = 4 \times 2 \times 5.75 \times (11.5 - 1.68)^2 + \frac{1}{12} \times 0.5 \times 23^3$
$+ 2 \times 21 \times 11.5^2$
$= 4{,}436 + 506 + 5{,}555 = 10{,}497$

$S_{2-2} = \frac{10{,}497}{11.5} = 913$, $r = 11.5$
$\ell/r \approx$ very small

$P = 222$ kips

$f_P = 222/79.5 = 4.1$ ksi.

$f_{2-2} = 18{,}583/913 = 20.58$ ksi

$\frac{4.1}{30} + \frac{20.58}{30} = 0.82 < 1.0$ o.k

/BLUME
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SHEET NO. 64

JOB S. F. Bridge BY CKC DATE 8/13/79

SUBJECT 3rd St. Bridge - Stress Analysis CHK'D DATE

Beam Elements

$= 647$

$P = -1{,}009 \quad I \quad (1586 + 0.67 \times 533)/Z$

D.L. EQ. X EQ Y

$= -1{,}657$ K

$f_p = \frac{1657}{95.7} = 17.3$ ksi

$M_{33} = 492 + (14{,}230 + 0.67 \times 9144)/Z$

D.L. EQ. Z + EQ. Y

$= 7277$ K-in

$f_{3-3} = \frac{7277}{1244} = 5.85$

$\frac{17.3}{1.7 \times 15.7} + \frac{5.85}{30} = 0.64 + 0.20 = 0.84 < 1.0$ O.K

$M_{2-2} = 4828 + (2311 + 0.67 \times 2730)/Z$

D.L. EQ. X EQ. Y

$= 6208$

$f_{2-2} = \frac{6208}{687} = 9.03$ ksi

$\frac{9.03}{30} = 0.3$

$\frac{17.3}{1.7 \times 15.7} + \frac{9.03}{30} = 0.64 + 0.3 = 0.94 < 1.0$ O.K.

Beam Elements

△ :

$$P = -1781 \pm (1679 + 0.67 \times 589)/2 \quad (\pm 691)$$

D.L. EQ. X EQ Y

$= -2472$ K

$$f_p = \frac{2472}{155.9} = -15.8 \text{ ksi}$$

$$M_{3\text{-}3} = 1252 + (127{,}100 + 0.67 \times 3346)/2$$

D.L. EQ Z EQ Y

$= 44{,}365$

$$f_{3\text{-}3} = \frac{44365}{1794} = 24.7$$

$$\frac{15.8}{1.7 \times 16.6} + \frac{24.7}{30} = 0.56 + 0.83 = 1.38 > 1.0 \leftarrow$$

△ :

$$P = -1627 \pm (1627 + 0.67 \times 579)/2 \quad (\pm 672)$$

D.L EQ. X EQ Y

$= -2{,}299$ K

$$f_p = \frac{2{,}299}{155.9} = -14.7$$

$$M_{3\text{-}3} = 1802 + (127{,}100 + 0.67 \times 1469)/2$$

D.L. EQ. Z EQ. Y

$= 44{,}497$

$$f_{3\text{-}3} = \frac{44497}{1794} = 24.8$$

$$\frac{14.7}{1.7 \times 16.6} + \frac{24.8}{30} = 0.52 + 0.83 = 1.35 > 1.0 \leftarrow$$

Beam Elements

37 :

$$P = +930 \pm (263 + 0.67 \times 389)/2 \quad (\pm 175)$$

D.L. EQ. X EQ Y

$= 1105$ K

$$f_p = \frac{1105}{8475} = 13.0$$

$$M_{2-2} = 7,540 + (3,447 + 0.67 \times 5149)/2 \quad (3299)$$

D.L. EQ. X EQ Y

$= 9,839$ K-in

$$f_{2-2} = \frac{9839}{1550} = 6.3$$

$$\frac{13}{30} + \frac{6.3}{30} = 0.64 < 1.0 \quad \text{O.K.}$$

37 :

$$P = -1301 \pm (346 + 0.67 \times 527)/2 \quad (\pm 233)$$

D.L. EQ. X EQ Y

$= -1534$

$$f_p = \frac{1534}{121} = 12.7$$

$$M_{3-3} = 2,393 + (17,190 + 0.67 \times 5967)/2$$

D.L. EQ. Z EQ. Y

$= 9,456$

$$f_{3-3} = \frac{9456}{2906} = 3.2$$

$$\frac{-12.7}{1.7 \times 14.8} + \frac{3.2}{30} = 0.50 + 0.11 = 0.61 < 1.0 \quad \text{O.K.}$$

$$M_{2-2} = 4605 + (4445 + 0.67 \times 3621)/2$$

D.L. EQ. X EQ Y

$= 6,895$

$$f_{2-2} = \frac{6,895}{812} = 8.49$$

$$0.5 + \frac{8.49}{30} = 0.5 + 0.28 = 0.78 < 1.0 \quad \text{O.K.}$$

Beam Elements

42 :

$$P = +1434 \pm (372 + 0.67 \times 5.41)/2$$

D.L EQ X EQ Y (± 249)

$= 1679$

$$f_p = \frac{1679}{100.7} = 16.7 \text{ ksi}$$

$$M_{3-3} = 2,458 + (449 + 0.67 \times 1400)/2$$

D.L. EQ. X EQ Y

$= 2920$

$$f_{3-3} = \frac{2920}{678} = 4.3$$

$$\frac{16.7}{30} + \frac{4.3}{30} = 0.70 < 1.0 \quad \text{O.K}$$

$$M_{3-3} = 1022 + (4815 + 0.67 \times 1676)/2$$

D.L. EQ Z EQ Y

$= 3,022$

$$f_{3-3} = \frac{3,022}{2132} = 1.41$$

$$\frac{16.7}{30} + \frac{1.41}{30} = 0.6 < 1.0 \quad \text{O.K}$$

43 :

$$P = -1,147 \pm (654 + 0.67 \times 377)/2$$

D.L EQ X EQ Y (± 312)

$= -1459$

$$f_p = \frac{1459}{88} = -16.58$$

$$M_{3-3} = 2,348 + (10,640 + 0.67 \times 1,444)/2$$

D.L EQ.Z EQ. Y.

$= 6,217$ k-in

$$f_{3-3} = \frac{6217}{2281} = 2.7$$

$$\frac{16.58}{1.7 \times 15.8} + \frac{2.7}{30} = 0.62 + 0.09 = 0.71 < 1.0 \quad \text{O.K.}$$

$M_{2-2} = 4844 + (1806 + 0.67 \times 2368)/2 = 5975$

$f_{2-2} = 5975/507 = 11.79/15 = 0.79$ $0.62 + 0.79 = 1.1$ ←

Beam Elements

4 : $P = -947 \pm (505 + 0.67 \times 281)/2$ (= 231)
D.L. EQ X EQ Y
$= -1178$

$f_p = \frac{1178}{68.9} = 17.1$

$M_{2-2} = 4,881 + (1,470 + 0.67 \times 2310)/2$
D.L. EQ X EQ Y
$= 5,887$

$f_{2-2} = \frac{5887}{492} = 12$

$\frac{17.1}{1.7 \times 160} + \frac{12}{30} = 0.63 + 0.40 = 1.03$ say ok

5 : $P = 780 \pm (227 + 0.67 \times 438)/2$ (= 173)
D.L. EQ. X EQ. Y
$= 953$

$f_p = \frac{953}{71.3} = 13.4$

$M_{3-3} = 655 + (1825 + 0.67 \times 4,480)/2$
D.L. EQ. X EQ Y

$= 2,263$ k-in.

$f_{3-3} = \frac{2263}{1461} = 1.60$

$M_{2-2} = 1345 + (1079 + 0.67 \times 1345)/2$
D.L. EQ. X EQ. Y

$= 2,005$

$f_{2-2} = \frac{2005}{580} = 3.5$

$\frac{13.4}{30} + \frac{3.5}{30} = 0.56 < 1.0$ o.K

Beam Elements

4 :

$$P = 715 \pm (806 + 0.67 \times 318)/2 \quad \pm 340$$

$$= 1055$$

$$f_p = \frac{1055}{81.5} = 12.9$$

$$M_{3-3} = 1027 + (42{,}280 + 0.67 \times 13{,}760)/2$$

D.L EQ. Z EQ. Y

$$= 18{,}393$$

$$f_{3-3} = \frac{18{,}393}{1922} = 9.6 \quad , \quad \frac{12.9}{30} + \frac{9.6}{30} = 0.75 < 1.0$$

O.K

$$M_{2-2} = 2953 + (1677 + 0.67 \times 1381)/2$$

D.L. EQ. X EQ. Y

$$= 3820$$

$$f_{2-2} = \frac{3820}{479} = 8.0$$

5 :

$$P = 589 + (564 + 0.67 \times 212)/2$$

D.L EQ. X EQ. Y

$$= 824$$

$$f_p = \frac{824}{60.9} = 13.5$$

$$M_{3-3} = 1214 + (30{,}410 + 0.67 \times 15{,}590)/2$$

EQ. Z EQ Y

$$= 14{,}832$$

$$f_{3-3} = \frac{14{,}832}{1333} = 11.1$$

$$\frac{13.5}{30} + \frac{11.1}{30} = 0.82 < 1.0 \quad \text{O.K.}$$

Beam Elements

$\Delta$ :

$$P = -1268 \pm (1101 + 0.67 \times 863)/2 = 515$$

D.L. EQ. X EQ. Y

$$= -1783$$

$$f_P = \frac{-1783}{132.4} = 13.46$$

$$M_{2-2} = 8,334 + (2962 + 0.67 \times 3985)/2$$

EQ X EQ Y

$$= 10,211$$

$$f_{2-2} = \frac{10211}{971} = 10.5 \qquad \frac{13.46}{1.7 \times 16.7} + \frac{10.5}{30} = 0.47 + 0.35 = 0.82 < 1.0$$

$$M_{3-3} = 1153 + (5010 + 0.67 \times 3814)/2$$

O.K.

$$= 3674$$

$$f_{3-3} = \frac{3674}{3118} = 1.2$$

Trunnion Supports

$$P = -1{,}004 \pm [1469 + 0.3 \times 486]/2$$

D.L. EQ X + EQ Z (1807)

$$= -1811 \text{ K}$$

$$f_p = \frac{1811}{79.5} = 22.8 \text{ ksi}$$

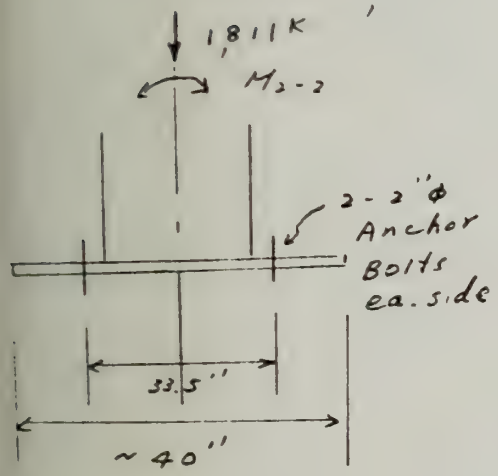
$$M_{2-2} = 8154 + (5{,}995 + 0.67 \times 8725)/2$$

D.L. EQ.X + EQ Y

$$= 14{,}074 \text{ K-in}$$

$$M_{3-3} = 247 + (8688 + 0.67 \times 665)/2$$

$$= 4{,}664 \text{ K-in}$$




$$\sigma = \frac{P}{A} \pm \frac{Mc}{I}$$

$$= \frac{1811}{2880} \pm \frac{14{,}074}{19{,}200}$$

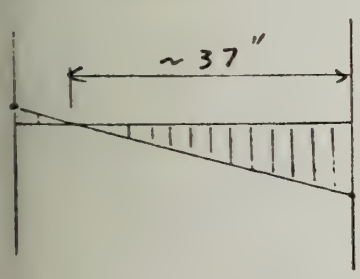
$$= 0.629 \pm 0.733$$

$$= 1.36 \text{ or } -0.104$$

$A = 40 \times 72$
$= 2{,}880 \text{ in}^2$

$I = \frac{1}{12} \times 40^3 \times 72$
$= 384{,}000$

$S = I/20 = 19{,}200$




$$C = \frac{1}{2} \times 1.36 \times 37 \times 72$$

$$= 1811 \sim P$$

∴ No Tension will take place for anchor bolts.

CTWT Support

65 :

$$P = -1{,}996 \pm (1202 + 0.67 \times 605)/2 \quad (= 806)$$

D.L. EQX + EQY

$= -2799$ K

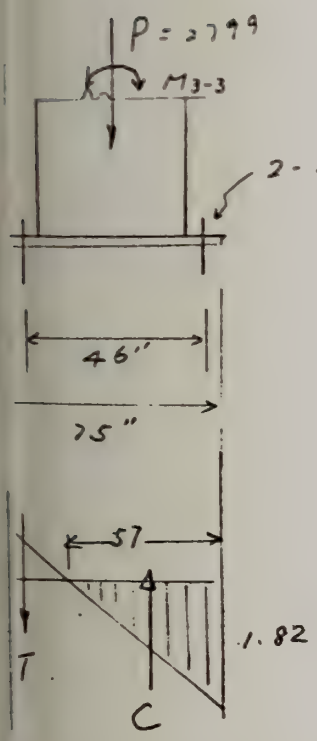
$$M_{2\cdot2} = 7{,}771 + (5{,}202 + 0.67 \times 6748)/2$$

D.L. EQZ + EQY

$= 12{,}633$ K-in

$$M_{3\cdot3} = 444 + (127{,}300 + 0.67 \times 25552)/2$$

$= 64{,}949$ K-in




$A = .75'' \times 58 = 4{,}350$ in²

$S = I/c = \frac{1}{12} \times 75^3 \cdot 58 / 37.5 = 54{,}375$

$$\sigma = \frac{P}{A} \pm \frac{M_{3\cdot3}}{S}$$

$$= \frac{2{,}799}{4{,}350} \pm \frac{64{,}948}{54{,}375} = 0.63 \pm 1.19$$

$= 1.82$ or $-0.56$

$C = \frac{1}{2} \times 57 \times 1.83 \times 58$

$= 3{,}025$

$T = 3{,}025 - 2799 = 225$ K — Demand

$T = 2 \times \frac{\pi}{4} \times 2^2 \times 40 \times 1.7$ ← use A325 H.S.

$= 427$ K > Demand O.K.

Columbia Basin

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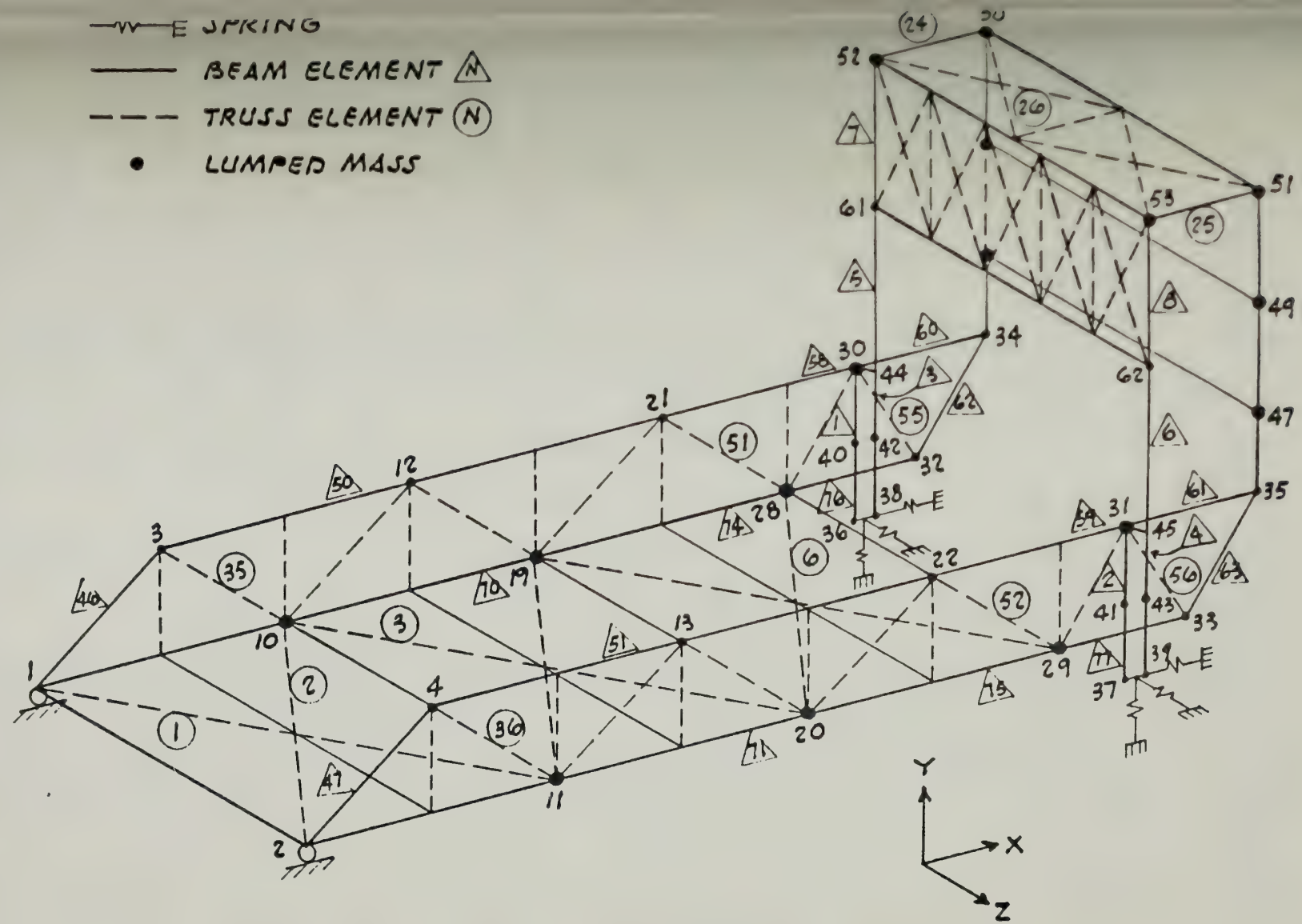


MATHEMATICAL MODEL

4TH ST. BRIDGE OVER CHANNEL

R/BLUME
Jessie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 2

O. JOB S. F. Bridge Evaluation BY CKC DATE 6/22/84

N SUBJECT 4th St. Bridge CHK'D DATE

Beam Elements

| Number I.D. | Nodal pt. | prop. I.D. | K | A | $I_{2-2}$ | $I_{3-3}$ | Section | Note |
|---|---|---|---|---|---|---|---|---|
| 1 | 36-30 | 1 | 32 | 69.2 | 50,446 | 14,521 | | Trunnion Support |
| 2 | 37-31 | 1 | 33 | " | " | " | | " |
| 3 | 38-44 | 2 | 32 | 51.5 | 630 | 7,175 | | Frame Post |
| 4 | 39-45 | 2 | 33 | " | " | " | | " |
| 5 | 44-61 | 2 | 32 | " | " | " | | " |
| 6 | 45-62 | 2 | 33 | " | " | " | | " |
| 7 | 61-52 | 2 | 32 | " | | | | " |
| 8 | 62-53 | 2 | 33 | " | | | | " |
| 9 | 52-55 | 3 | 63 | 16.7 | 3,047 | 12,190 | | Frame Top Beam |
| 0 | 55-57 | 3 | 63 | " | | | | |
| 1 | 57-54 | 3 | 63 | " | | | | |
| 2 | 54-58 | 3 | 63 | " | | | | |
| 3 | 58-56 | 3 | 63 | " | | | | |
| 4 | 56-53 | 3 | 63 | " | | | | |
| 5 | 36-40 | 5 | 32 | ∞ | | | | Fictitious Support |
| 6 | 37-41 | 5 | 33 | | | | | |
| 7 | 40-38 | 5 | 32 | | | | | |
| 8 | 41-39 | 5 | 33 | | | | | |
| 9 | 42-40 | 4 | 32 | 28,224 | 5,530,000 | 5,530,000 | | pile cap |
| 0 | 43-41 | 4 | 33 | " | " | " | | " |
| 1 | 34-46 | 7 | 47 | 57.2 | 967 | 2,210 | | CTWT Arm |
| 2 | 35-47 | 7 | 46 | " | " | " | | " |
| 3 | 46-48 | 5 | 49 | ∞ | | | | CTWT |
| 4 | 47-49 | " | 48 | | | | | |
| 5 | 48-50 | " | 51 | | | | | |
| 6 | 49-51 | " | 50 | | | | | |
| 7 | 59-50 | " | 60 | | | | | |
| 8 | 51-59 | " | 60 | | | | | |
| 9 | 2-1 | 6 | 32 | 61.4 | 17,567 | 475 | | Floor Beam |
| 0 | 7-5 | 6 | 32 | | | | | " |
| 1 | 6-7 | 6 | 32 | | | | | " |
| 2 | 10-11 | 6 | 32 | | | | | " |

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SHEET NO. 3

JOB S.F. Bridge Evaluation BY CKC DATE 6/22/84

SUBJECT 4th St. Bridge CHK'D DATE

## Beam Elements

| Number ID | Nodal pts | prop. I.D. | K | A | $I_{2-2}$ | $I_{3-3}$ | Section | Note |
|---|---|---|---|---|---|---|---|---|
| 33 | 14-16 | 6 | 32 | | | | | Floor Beam |
| 34 | 15-16 | " | " | | | | | |
| 35 | 20-19 | " | " | | | | | |
| 36 | 25-23 | " | " | | | | | |
| 37 | 24-25 | " | " | | | | | |
| 38 | 29-28 | " | 32 | | | | | |
| 39 | 47-46 | 5 | 59 | ∞ | ∞ | ∞ | | CTWT |
| 40 | 49-48 | 5 | " | | | | | |
| 41 | 61-63 | 8 | 54 | 8.0 | 1,458 | 72 | | Frame Bottom Beam |
| 42 | 63-65 | " | " | | | | | |
| 43 | 65-66 | " | " | | | | | |
| 44 | 66-64 | " | " | | | | | |
| 45 | 64-62 | " | " | | | | | |
| 46 | 1-3 | 9 | 4 | 26.5 | 730. | 4009. | | Bascular Truss Top Chords |
| 47 | 2-4 | " | 3 | " | " | " | | |
| 48 | 3-8 | 10 | 9 | 30.9 | 820 | 4,084 | | |
| 49 | 4-9 | " | 8 | | | | | |
| 50 | 8-12 | " | 13 | | | | | |
| 51 | 9-13 | " | 12 | | | | | |
| 52 | 12-17 | " | 18 | 47.5 | 1,126 | 6,269 | | |
| 53 | 13-18 | " | 17 | | | | | |
| 54 | 17-21 | " | 22 | | | | | |
| 55 | 18-22 | " | 21 | | | | | |
| 56 | 21-26 | 12 | 27 | 595 | 1270 | 7856 | | |
| 57 | 22-27 | " | 26 | | | | | |
| 58 | 26-30 | " | 31 | | | | | |
| 59 | 27-31 | " | 30 | | | | | |
| 60 | 30-34 | 13 | 35 | 70.7 | 1,424 | 9,345 | | |
| 61 | 31-35 | " | 34 | | | | | |
| 62 | 32-34 | 14 | 35 | 58.9 | 1242 | 7,789 | | |
| 63 | 33-35 | 14 | 34 | | | | | |

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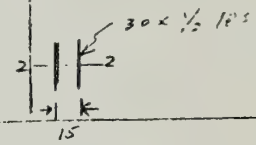
rancisco, California 94105

SHEET NO. 4

NO. JOB S. F. Bridge Evaluation BY CKC DATE 5/22/8

SUBJECT 4th st. Bridge CHK'D DATE

Beam Elements

| Member I.D. | Nodal pts | prop. I.D. | K | A | $I_{2-2}$ | $I_{3-3}$ | Section | Note |
|---|---|---|---|---|---|---|---|---|
| 64 | 1-5 | 15 | 6 | 23.2 | 698 | 3068 | | Truss Bottom chord |
| 65 | 2-6 | 15 | 5 | | | | | |
| 66 | 5-10 | " | 11 | | | | | |
| 67 | 6-11 | " | 10 | | | | | |
| 68 | 10-14 | 16 | 15 | 38.0 | 952 | 5,026 | | |
| 69 | 11-15 | " | 14 | | | | | |
| 70 | 14-19 | " | 20 | | | | | |
| 71 | 15-20 | " | 19 | | | | | |
| 72 | 19-23 | 17 | 24 | 40.3 | 968 | 5,330 | | |
| 73 | 20-24 | " | 23 | | | | | |
| 74 | 23-28 | " | 29 | | | | | |
| 75 | 24-29 | " | 28 | | | | | |
| 76 | 28-32 | 18 | 35 | 58.9 | 1,242 | 7,789 | | |
| 77 | 29-33 | " | 32 | " | " | " | | |
| 78 | 30-44 | 5 | 45 | 30 | 2,250 | 1,688 |   | Link |
| 79 | 31-43 | 5 | 44 | " | " | " | | " |

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rancisco, California 94105

SHEET NO. 5

NO. JOB S. F. Bridge Evaluation BY CKC DATE 6/26/84

SUBJECT 4th St. Bridge CHK'D DATE

Truss Elements

| Member I.D. | Nodal pts | prop. I.D. | A | Section | Note |
|---|---|---|---|---|---|
| 1 | 1-7 | 21 | 2.86 | ∠ 4 × 4 × 3/8 | Floor Bracing |
| 2 | 10-7 | 21 | " | | |
| 3 | 18-16 | " | " | | |
| 4 | 19-16 | " | " | | |
| 5 | 19-15 | " | " | | |
| 6 | 28-25 | " | " | | |
| 7 | 46-49 | 29 | ∞ | | Fictitious CTWT Bracing |
| 8 | 48-47 | " | " | | |
| 9 | 25-29 | 21 | 2.86 | | Floor Bracing |
| 10 | 52-63 | 23 | 8.40 | 2 ∠s 3 1/2 × 3 1/2 × 5/16 | Tower Bracing |
| 11 | 61-55 | " | " | | |
| 12 | 55-65 | " | " | | |
| 13 | 63-57 | " | " | | |
| 14 | 57-66 | " | " | | |
| 15 | 65-58 | " | " | | |
| 16 | 58-64 | " | " | | |
| 17 | 66-56 | " | " | | |
| 18 | 56-62 | " | " | | |
| 19 | 64-53 | " | " | | |
| 20 | 55-63 | " | " | | |
| 21 | 57-65 | " | " | | |
| 22 | 58-66 | " | " | | |
| 23 | 56-64 | " | " | | |
| 24 | 52-50 | 25 | 20. | 2 - 15 C33# | Link |
| 25 | 53-51 | 25 | " | | " |
| 26 | 52-59 | 27 | 4.2 | 2-∠s 4 × 3 × 5/16 | Link Truss |
| 27 | 50-54 | " | " | | |
| 28 | 54-51 | " | " | | |
| 29 | 59-53 | " | " | | |
| 30 | 54-59 | " | " | | |
| 31/32 | 48-51/49-50 | 29 | ∞ | | Fictitious CTWT Brace |

FS/BLUME
Bassie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 6

JOB NO. JOB S. F Bridge Evaluation BY CKC DATE 6/5/84

SUBJECT 4th St. Bridge CHK'D DATE

## Truss Elements

| Member I.D. | Nodal pts. | prop. I.D. | A | Section | Note |
|---|---|---|---|---|---|
| 33 | 3 - 5 | 18 | 14.12 | 4 - ∠s 5 × 3½ × 7/16 | Bascule Truss |
| 34 | 4 - 6 | 18 | " | | |
| 35 | 3 - 10 | 11 | 24.7 | 4 - ∠s 6 × 4 × 7/16 , 1 PL 21½ × 3/8 | |
| 36 | 4 - 11 | 11 | " | | |
| 37 | 8 - 10 | 19 | 10.24 | 4 - ∠s 5 × 3½ × 5/16 | |
| 38 | 9 - 11 | 19 | " | | |
| 39 | 10 - 12 | 12 | 21.74 | 4 - ∠s 6 × 3½ × 3/8 , 1 PL 21½ × 3/8 | |
| 40 | 11 - 13 | 12 | " | | |
| 41 | 12 - 14 | 18 | 14.12 | | |
| 42 | 13 - 15 | 18 | 14.12 | | |
| 43 | 12 - 19 | 13 | 27.1 | 4 - ∠s 6 × 4 × ½ , 1 PL 21½ × 3/8 | |
| 44 | 13 - 20 | 13 | 27.1 | | |
| 45 | 17 - 19 | 19 | 10.2 | 4 - ∠s 5 × 3½ × 5/16 | |
| 46 | 18 - 20 | 19 | 10.2 | | |
| 47 | 19 - 21 | 14 | 32.74 | 4 - ∠s 7 × 3½ × 5/8 , 1 PL 21½ × 3/8 | |
| 48 | 20 - 22 | 14 | 32.74 | | |
| 49 | 21 - 23 | 18 | | | |
| 50 | 22 - 24 | 18 | | | |
| 51 | 21 - 28 | 15 | 41.50 | 4 ∠s 8 × 6 × 5/8 , 1 PL 21½ × 3/8 | |
| 52 | 22 - 29 | 15 | 41.5 | | |
| 53 | 26 - 28 | 19 | | | |
| 54 | 27 - 29 | 19 | | | |
| 55 | 30 - 32 | 17 | 70.67 | | |
| 56 | 31 - 33 | 17 | 70.67 | | |
| 57 | 28 - 30 | 16 | 38.02 | | |
| 58 | 29 - 31 | 16 | 38.02 | | |
| 59 | 2 - 7 | 21 | 2.86 | | Floor Bracing |
| 60 | 7 - 11 | 21 | | | |
| 61 | 16 - 20 | " | | | |
| 62 | 16 - 11 | " | | | |
| 63 | 20 - 25 | " | | | |

Nodal weights - Drawing # 369
3-D model

Truss -

| | | W (K) | x (ft) |
|---|---|---|---|
| pt. 1,2 | $11.9 + \frac{1}{2}\times 4 + \frac{1}{2}\times 4.2 + \frac{1}{8}\times 23$ (2.88) $+ \frac{1}{14}(233.8)$ (16.7) | = 52.28 | × 94 = 4,914.3 |
| pt. 5,6 | $\frac{1}{2}\times 4 + \frac{1}{2}\times 4.2 + 1.96 + \frac{1}{3}\times 2.74$ (1.37) $+ \frac{1}{4}\times 23$ (5.75) $+ \frac{1}{5}\times 51.2$ (10.24) $+ \frac{1}{4}\times 12.2 + \frac{1}{7}(233.8)$ (33.4) | = 59.9 | × 79.65 = 4771.6 |
| pt. 10,11 | $\frac{1}{2}\times 2.74 + \frac{1}{4}\times 23 + \frac{1}{5}\times 51.2 + \frac{1}{2}\times 12.2 + \frac{1}{2}\times 2.4 + 1.39 + \frac{1}{7}(233.8) + \frac{1}{2}\times 3.8$ | = 61.3 | × 65.25 = 4,000 |
| pt. 14,15 | $\frac{1}{4}\times 23 + \frac{1}{5}\times 51.2 + \frac{1}{4}\times 12.2 + \frac{1}{6}\times 28.14$ (4.69) $+ 3.24 + \frac{1}{2}\times 3.8$ (+3.06) $+ \frac{1}{2}\times 2.4 + \frac{1}{2}\times 2.98 + \frac{1}{2}\times 3.8 + \frac{1}{7}(233.8)$ | = 64.8 | × 50.875 = 3,296 |
| pt. 19,20 | $\frac{1}{8}\times 23 + \frac{1}{5}\times 51.2 + \frac{1}{5}\times 28.1$ (4.67) $+ \frac{1}{3}\times 28.14 + \frac{1}{2}\times 2.98 + \frac{1}{2}\times 3.56 + \frac{1}{2}\times 3.1 + \frac{1}{7}(233.8)$ | = 65.45 | × 36.5 = 2388.9 |
| pt. 23,24 | $\frac{1}{5}\times 51.2 + \frac{1}{3}\times 28.1 + \frac{1}{3}\times 28.14 + \frac{1}{2}\times 3.56 + \frac{1}{2}\times 4.56 + \frac{1}{2}\times 3.8 + \frac{1}{7}(233.8)$ | = 68.46 | × 22.16 = 1517 |
| pt. 28,29 | $9.15 + \frac{1}{3}\times 28.1 + \frac{1}{6}\times 28.14 + \frac{1}{2}\times 4.56 + \frac{1}{2}\times 3.1 + \frac{1}{3}(4.9 + 6.7)$ (2.87) $+ \frac{1}{7}(233.8) + 0.67$ | = 64.9 | × 7.75 = 503 |
| pt. 32,33 | $\frac{1}{6}\times 28.1 + \frac{1}{2}\times 20.6 + \frac{1}{3}(4.9 + 6.7) + \frac{1}{14}(233.8) + 5.66$ | = 41.2 | × (-7.0) = -288.4 |
| pt. 34,35 | $\frac{1}{2}\times 8.64 + \frac{1}{2}\times 20.6$ | = 14.62 | × (-14.7) = -214.9 |
| pt. 30,31 | $\frac{1}{2}\times 8.64 + \frac{1}{3}(4.9 + 6.7)$ | = 8.2 | |
| | | .501 K | 20,887 K-' |

$\Sigma M$ @ ℄ of Trunnion past =

$x = 20{,}887 / 501 = 41.7'$

$41.7 \times 250 - 704 \times 14.75 - (5+3+6) \times 2.25$

$10{,}425 - 10{,}384 - 32 = 9 \approx 0$ say o.k.

JFS/BLUME
0 essie Street (at New Montgomery)
n Francisco, California 94105

SHEET NO. 8

JOB: S. F. Bridge - 4th over channel BY CHC DATE 5/19/84

SUBJECT: Member properties CHK'D DATE

Truss Elements - 3-D Model

Truss :

| I.D. | Member | A ($in^2$) | Sections | Material prop. No. |
|---|---|---|---|---|
| 1 | - 3 | 26.48 | ][ 2 - 15 C 45# | 1 |
| 3, 5 | 3 - 8 - 12 | 31.45 | ][ 2 - 15 C 35, 2 PL 14 1/2 x 3/8" | 2 |
| 7, 9 | 12 - 17 - 21 | 47.55 | 2 - 15 C 50, 2 PL 14 1/2 x 5/8 | 3 |
| 11, 13 | 21 - 26 - 30 | 59.55 | ][ DO, DO, 2 PL 12 x 1/2 | 4 |
| 15 | 30 - 34 | 70.67 | 2 - 15 C 50, 2 PL 14 1/2 x 3/4, 2 PL 12 x 13/16 | 5 |
| 19, 21 | 1 - 5 - 10 | 23.52 | ][ 2 - 15 C 40 | 6 |
| 23, 25 | 10 - 14 - 19 | 38.02 | ][ 2 - 15 C 40, 2 PL 14 1/2 x 1/2 | 7 |
| 27, 29 | 19, 23, 28 | 40.3 | 2 - 15 C 50, 2 PL 14 1/2 x 3/8 | 8 |
| 31 | 28 - 32 | 58.92 | 2 - 15 C 50, 2 PL 14 1/2 x 1/2, 2 PL 12 x 5/8 | 9 |
| 17 | 32 - 34 | 58.92 | | 10 |
| 35 | 3 - 10 | 24.78 | ][ 4 LS 6 x 4 x 7/16, 1 PL 21 1/2 x 3/8 | 11 |
| 39 | 10 - 12 | 21.74 | 4 LS 6 x 3 1/2 x 3/8, 1 PL DO | 12 |
| 43 | 12 - 19 | 27.06 | 4 LS 6 x 4 x 1/2, 1 PL DO | 13 |
| 47 | 19 - 21 | 32.74 | 4 LS 7 x 3 1/2 x 5/8, 1 PL 21 1/2 x 3/8 | 14 |
| 51 | 21 - 28 | 41.50 | 4 LS 8 x 6 x 5/8, 1 PL 21 1/2 x 3/8 | 15 |
| 108 | 28 - 30 | 38.02 | ][ (Same as 7 - 10 - 13) | 16 |
| 55 | 30 - 32 | 70.67 | (Same as 21 - 23) | 17 |
| 33, 41, 49 | 3 - 5, 12 - 14, 21 - 23 | 14.12 | ][ 4 LS 5 x 3 1/2 x 7/16 | 18 |
| 37, 45, 53 | 8 - 10, 17 - 19, 26 - 28 | 10.24 | 4 LS 5 x 3 1/2 x 5/16 | 19 |
| | | | | 20 |

Floor System :

| | | | |
|---|---|---|---|
| Diagonal | 2.86 | 1 L 4 x 4 x 3/8 | 21 |
| Floor Beam | 61.4 | 1 WOB PL 50 x 5/16, 4 LS 6 x 6 x 1/2, 4 PL 13 x 7/16 | 22 |

Tower Frame :

| | | | |
|---|---|---|---|
| Diagonal | 8.4 | 2 LS 3 1/2 x 3 1/2 x 5/16 | 23 |
| Bottom Beam | 8.1 | 2 - 8 C 13.75# | 24 |

Link Frame :

| | | | |
|---|---|---|---|
| Link | 20 | 2 - 15 C 33# | 25 |
| Beam | 8.4 | 4 LS 4 x 3 x 5/16 | 26 |
| Diagonal | 4.2 | 2 LS 4 x 3 x 5/16 | 27 |

Transv. Frame - Nodal masses

| | | | A (in²) | W (#/') |
|---|---|---|---|---|
| pt. 52, 53 | 2 ∠s 3½ × 3½ × 5/16 | T & B | 4.18 | 14.4 |
| | 2 ∠s 3 × 2½ × 5/16 | Diag. | 3.24 | 11.2 |
| | 2 ∠s 3½ × 3½ × 5/16 | Diag. | 4.18 | 14.4 |
| | 2 - 15 C 33# | Col. | | 66 |
| | 2¼ × 3/8 | D.L | | 2.9 |

$W = 66 \times (10.5') + 14.4 \times 2 \times 25' + 11.2 \times 10 \times 6'$
693 720 672

$14.4 \times 18 \times 3 + 2.9 \times 20 \times 2.5' \times 2$
777 290

$12.7\ (5/16\ \text{PL}) \times (5.5 \times 4.5 + 5.5 \times 2.5 + 6 \times 2.5)$
679

$14.4 \times 2 \times 12.5' \times 2 + 18' \times 2.25' \times 12.7\ (5/16\ \text{PL})$
720 514

$= 5065 + 20\%$ for connections + misc.

$= 6.1^K$

pt. 61, 62, -

$W = 66 \times 15' + 14.4 \times 3 \times 18 + 13.75 \times 2 \times 25' + 15 \times 2.25 \times 12.7$

$= 495 + 778 + 687 + 428$

$= 2388 + 20\%$ for connections + misc.

$= 3^K$

pt. 48, 49 -

$W = 704^K$ (counterweight)

pt. 34, 35

1 - 15 I 42# -
2 - 15 C 45#
2 - PL ½"
1 Base PL 5/8"

$5' \times (42 + 45) + 2 \times \frac{2.75 + 2.25}{2} \times 3 \times 20\#$

$+ 2.75 \times 2.5 \times 25.5\#$

$= 435 + 300 + 175 = 910 + 20\%$

$= 1100 + \frac{1}{2}(18640 + 20660) \leftarrow$ Drawing 315

$= 15.75^K$

Truss Elements - continued

| I.D. | Member | A | Sections | Material NO. |
|---|---|---|---|---|
| 102 | 46-34 | 43.2 | 1-15I42#, 2-15C45#, 2-Pls 18 x 1/2 | 28 |
| 98~101 | Counter Wt | ∞ | ∞ | 29 |
| 106 | 30-44 | ∞ | Rigid Links between tower / Trunnion posts | 29 |

Beam-Column Elements

| I.D. | Member | A | $A_2$ | $A_3$ | $I_{22}$ | $I_{33}$ | Sections | Mat. NO |
|---|---|---|---|---|---|---|---|---|
| 1 | 30-36 | 69.2 | | | 50,446 | 14,521 | Trunnion post | 1 |
| 3.5.7 | 38-44-52 | 20.0 | | | 630 | 3,630 | Tower post | 2 |
| 9~14 | Top Beam | 16.7 | | | 12,190 | 3,047 | Tower Beam | 3 |
| 19 | 42-40 | 28,224 | | | 5,530,000 | 5,530,000 | Conc. cap 14'x14'x5' high | 4 |
| 15~18 | 36-40-38 37-41-39 | ∞ | | | ∞ | ∞ | ∞ | 5 |

## Section properties - Tower Frame

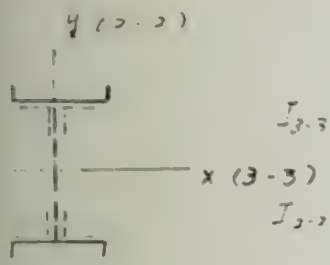
### Frame post

2 - 15 C 33#,

A = 9.96 I = 315 in⁴

4 - Ls 6 × 4 × 1/2, A = 9.5

1 - 1 1/2 × 1/2, I = 1/12 × 1/2 × (27)³ = 820




$I_{3-3} = I_x = 9.96 \times (13.5)^2 \times 2 = 3630 \text{ in}^4$
$2 \times 9.5 \times (27/2)^2 = 3463$
$820 = 820$
} 7,175

$I_{2-2} = I_y = 2 \times 315 = 630 \text{ in}^4$

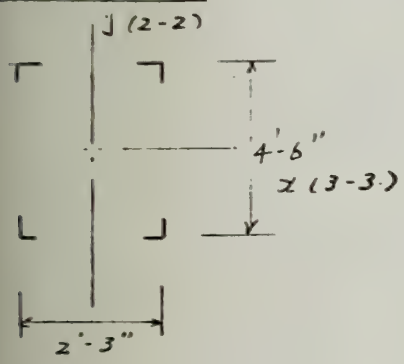
$A = 2 \times 9.96 = 20 \text{ in}^2$
$2 \times 9.5 = 18$
$27 \times 0.5 = 13.5$
} A = 51.5

### Link

2 - 15 C 33#

A = 9.96 in² × 2
= 20 in²

### Top Beam




4 - Ls 3 1/2 × 3 1/2 × 5/16 A = 4.18 in² Ea.

A = 4 × 4.18 = 16.72 in²

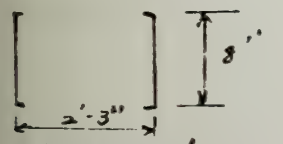
$I_x = 4 \times 4.18 \times (2.25 \times 12)^2$

$I_{3-3} = 12{,}189 \text{ in}^4$

$I_y = 4 \times 4.18 \times (13.5)^2$

$I_{2-2} = 3047 \text{ in}^4$

### Bottom Beam




2 - 8 C 13.75#

A = 4.04 in²
= 8.08 in²

### Diagonal

2 Ls 3 1/2 × 3 1/2 × 5/16

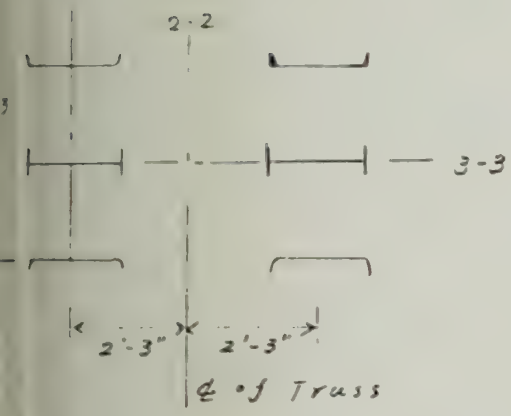
A = 2 × 4.18
= 8.36 in²

Section properties - Trans. Frame

Trunnion post

2 - 15 C 33#, 1 - 15 I 50#, D.L. 2½ × ⅜

A = 9.96 in²  A = 14.7 in²
W = 33#  W = 50
I = 315  I = 486
= 8.13  = 15.7




$A = 4 \times 9.96 + 2 \times 14.7$
$= 39.8 + 29.4 = 69.2 \text{ in}^2$

$I_{2-2} = \cancel{34.6 \times (3.7)^2 \times 2 = 5,446} \text{ in}^4$
$2(315 + 486 + 315) = 2,232$

$I_{3-3} = 2 \times 9.96 \times (13.5)^2 \times 2 = 14,521 \text{ in}^4$

$S_{2-2} = \frac{1116}{7.5} \times 2 = 298$
$S_{3-3} = 14,521/13.5 = 1076$

wt. $= 4 \times 33 + 2 \times 50 = 232$ #/ft --- col.

$3' \times 3' \times 15.3^{\#}$ (3/8" pl) × 10 } 1377
$+ 3/8 \times 34 \times 79 \times \frac{1}{12^3} \times 490$ } 286
1663# - cover PL

$232 \times 7.5' + 1663/2 = 1740 + 832$
$= 2572$ lbs + 20%
$= 3.1^{k}$

Nodal mass @ pt. 30/31
$= 3.1 + 4.2$ ← Drawing # 365
$= 7.3$

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SHEET NO. 13

JOB S. F. Bridges BY CKC DATE 6/30/19 u.

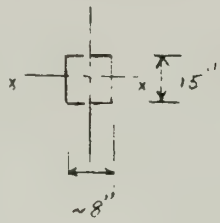
SUBJECT 4th St. over channel CHK'D DATE

Section properties - C. W. Link.

Link -

2 - 15 C 33 #

A = 20 in²




A = 20"

$I_{xx}$ = 2 × 315 = 630

$I_{yy}$ = 2 × 10 × (4 - 0.78)²
= 207

r = √(207/20) = 3.2

l/r = 180/3.2 = 56

Fa = 17.8 ksi
= 17.8 × 30/36
= 14.8 ksi

Beam

4 - Ls 4 × 3 × 5/16

A = 2.09 × 4 = 8.36 in²

Diagonal

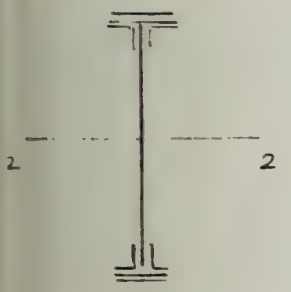
2 Ls 4 × 3 × 5/16

A = 2.09 × 2 = 4.18 in²

Floor System

1 web PL 50 × 5/16, 4 Ls 6 × 6 × 1/2, 4 PLs 13 × 7/16

A = 15.6 , = 11.5 - 2Ls = 5.7 ea.
= 77.7 - 2Ls



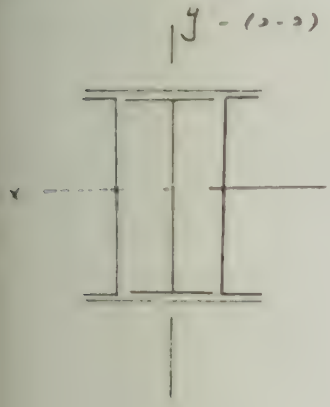

$\Sigma A = 15.6 + 2 \times 11.5 + 4 \times 5.7$
$= 61.4 \text{ in}^2$

$I_{xx} = \frac{1}{12} \times 50^3 \times \frac{5}{16} + 11.5 \times 25^2 + 2 \times 5.7 \times 25^2$

$I_{2-2} = 3255 + 7,187 + 7125$
$= 17,567 \text{ in}^4$

$I_{3-3} = 4 \times \frac{1}{12} \times 13^3 \times \frac{7}{16} + 2 \times 77.7$
$= 320 + 155 = 475 \text{ in}^4$

Counterweight post




15 I 42# 15 C 45 R 18 × 1/2

$I_x = 447$ $I_x = 375$

$I_y = 14.4$ $I_y = 10$

$A = 12.6$ $A = 13.3$

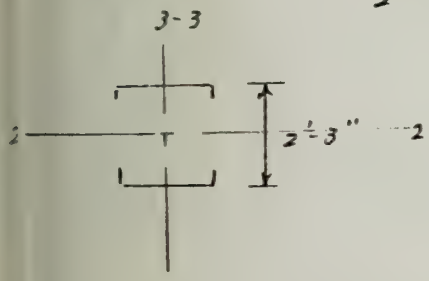
$A = 12.6 + 2 \times 13.3 + 18 = 57.2 \text{ in}^2$

$I_{x\text{-}x} = 447 + 2 \times 375 + 9 \times 2 \times 7.5^2$
$= 2210 \text{ in}^4$

$I_{y\text{-}y} = 14.4 + 2 \times 13.3 \times \left(\frac{5.5}{2} + 0.8\right)^2 + \frac{1}{12} \times 18^3 \times \frac{1}{2} \times 2$
$= 146 + 335 + 486$
$= 967 \text{ in}^4$

Bottom Chord of Trans. Frame -

2 - 8 C 13.75




$A = 4.0$
$I = 36 \text{ in}^4$

$A = 8$

$I_{22} = 2 \times 4 \times (13.5)^2$
$= 1{,}458 \text{ in}^4$

$I_{3\text{-}3} = 2 \times 36 = 72$

Member properties

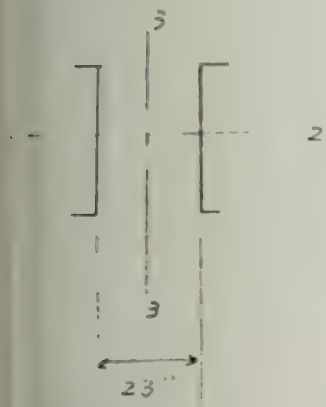
Beam elements

46, 47

1-3
2-4 } : ][ 2 - 15 C 45#

A = 13.25

I = 375




$\Sigma A = 26.50 \text{ in}^2$

$I_{2-2} = 2 \times 375 = 750 \text{ in}^4$

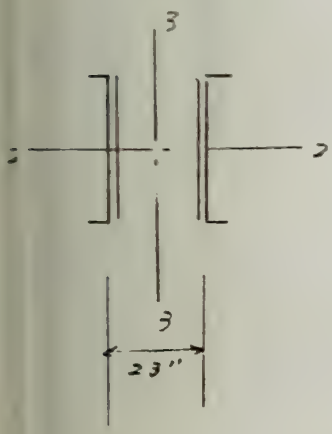
$I_{3-3} = 2 \times 13.25 \times (11.5 + 0.8)^2$

$= 4{,}009$

48 ~ 51

3-8
4-9
8-12
9-13 } : 2 - 15 C 35#, 2 PL's 14 1/2 x 3/8

A = 10, I = 315 A = 5.44




$\Sigma A = 2 \times 10 + 14.5 \times 3/8 \times 2$

$= 30.9$

$I_{2-2} = 2 \times 315 + 2 \times \frac{1}{12} \times 14.5^3 \times \frac{3}{8}$

$= 630 + 190 = 820 \text{ in}^4$

$I_{3-3} \doteq 2 \times 10 \times 11.5^2 + 2 \times 5.44 \times 11.5^2$

$= 4{,}084 \text{ in}^4$

## Member properties

### Beam Elements

53 - 54

12-17 / 13-18
17-21 / 18-22 } 2-15 C 50#, 2 PL 14 1/2 × 5/8

A = 14.7, I = 404, A = 9.06, I = 159

$\Sigma A = 2 \times 14.7 + 2 \times 9.06$
$= 47.5$

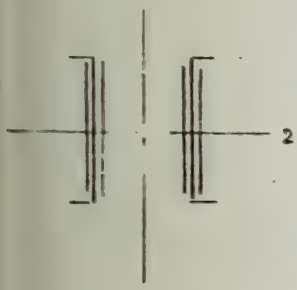
$I_{2-2} = 2 \times 404 + 2 \times 159$
$= 1126$

$I_{3-3} = 2 \times 147 \times 11.5^2 + 2 \times 9.06 \times 11.5^2$
$= 3,858 + 2381$
$= 6,269$

51 - 52

21-26 / 22-27
26-30 / 27-31 } 2-15 C 50# 2 PL 14 1/2 × 5/8

2 PL 12" × 1/2, A = 6 I = 72




$\Sigma A = 47.5 + 12 = 59.5$

$I_{2-2} = 1126 + 2 \times 72 = 1270$

$I_{3-3} = 6269 + 2 \times 6 \times 11.5^2$
$= 7856$

60, 61

30-34 / 31-35 : 2-15 C 50, 2 PL 14 1/2 × 3/4 { A = 10.88, I = 191

2 PL 12 × 13/16 { A = 9.75, $I = \frac{1}{12} \times 12^3 \times 13/16 = 117$

$\Sigma A = 2 \times 14.7 + 2 \times 10.88 + 2 \times 9.75$
$= 70.67$

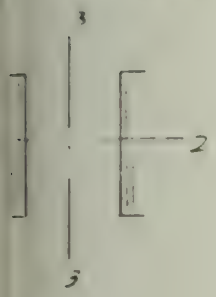
$I_{2-2} = 2 \times 404 + 2 \times 191 + 2 \times 117$
$= 1424$

$I_{3-3} = (2 \times 14.7 + 2 \times 10.88 + 2 \times 9.75) \times 11.5^2$
$= 9345$

Beam Elements

62 / 63
32-34 / 33-35 : 2 - 15 C 50, 2 PL 14 1/2 x 1/2 { A = 7.25, I = 127

2 PL 12 x 5/8 { A = 7.5, I = 90




$\Sigma A = 2 \times 14.7 + 2 \times 7.25 + 2 \times 7.5$
$= 58.9$

$I_{2-2} = 2 \times 404 + 2 \times 127 + 2 \times 90$
$= 1242$, $S_{2-2} = 166$

$I_{3-3} = 2 \times 11.5^2 (14.7 + 7.25 + 7.5)$
$= 7789$ $S_{3-3} =$

61 - 67
1-5 / 2-6
5-10 / 6-11 } : 2 15 C 40 A = 11.8
I = 349

$A = 2 \times 11.6 = 23.2$

$I_{2-2} = 2 \times 349 = 698$

$I_{3-3} = 2 \times 11.6 \times 11.5^2 = 3068$

51 - 57
10-14 / 11-15
14-19 / 15-20 } : 2 - 15 C 40
2 - PL 14 1/2 x 1/2 A = 7.25
I = 127

$A = 2 \times 11.6 + 2 \times 7.25$
$= 38$

$I_{2-2} = 2 \times 349 + 2 \times 127$
$= 952$

$I_{3-3} = 38 \times 11.5^2$
$= 5026$

/BLUME
ssie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 18

JOB S. F. Bridges BY DATE

SUBJECT 4th over channel CHK'D DATE

Beam Elements

$\triangle 52 - \triangle 55$

19-23 / 20-24
23-28 / 24-29

2 - 15 C 50
2 PL's 14 1/2 x 3/8 , A = 5.44 I = 80

$$SA = 2 \times 14.7 + 2 \times 5.44$$
$$= 40.3$$

$$I_{3-3} = 2 \times 400 + 2 \times 80$$
$$= 968$$

$$I_{3-3} = 40.3 \times 11.5^2$$
$$= 5{,}330$$

$\triangle 56 , 57$

28-32 / 29-33 :

2 - 15 C 50
2 PL's 14 1/2 x 1/2
2 - PL's 12 x 5/8

same as 32-34 / 33-35

30-44 / 31-45 :

A = ∞
I = ∞

assume used as linkage

Total - 16 piers . 12 piles per pier.

pile :

$K_v = 75\ ^k/_{in} \times 12 = 900\ ^k/_{in} \times 0.7 = 630\ ^k/_{in}$

pier : 4' $\phi$ dia. 25' high , $I = \frac{\pi d^4}{64} = 260{,}444$

$$K_p = \frac{3EI}{\ell^3} = \frac{3 \times 2{,}900 \times 0.260 \times 10^6}{(25 \times 12)^3}$$

$= 84\ ^k/_{in}$

$$K = \frac{1}{\frac{1}{630} + \frac{1}{84}} = \frac{1}{0.0016 + 0.0119} = 74\ ^k/_{in}$$

Longit. dir. - (X - Dir.)

$$\Sigma K = 74 \times 6 + \underbrace{\frac{34}{2} \times 75}_{\text{vert.}} + \overbrace{\frac{16}{2} \times \underbrace{75 \times 0.8}_{\text{batter}}}^{\text{Abutment}}$$

$= 444 + 1275 + 480 = 2199\ ^k/_{in}$ per support

Trans. Dir -

$\Sigma K$ = Longit.

Results of Seismic Evaluation - 4th Street Over Channel (Existing)

| Member* I.D. | Dead Load plus Seismic** | | | | | Note |
|---|---|---|---|---|---|---|
| | $f_a$ (Ksi) | $f_b$ (Ksi) | $\frac{f_a}{1.7F_a}$ | $\frac{f_b}{1.7F_b}$ | $\frac{f_a}{1.7F_a} + \frac{f_b}{1.7F_b}$ | |
| 1, 2 | 18.2 | 42.0 | 0.65 | 1.41 | 2.05 | X |
| 3, 4 | 14.1 | 21.3 | 0.52 | 0.71 | 1.23 | X |
| 5, 6 | 0.64 | 80.0 | 0.03 | 2.66 | 2.69 | X |
| 7, 8 | ∿ | 35.0 | ∿ | 1.17 | 1.17 | X |
| 46, 47 | 3.70 | 1.35 | 0.39 | 0.05 | 0.44 | |
| 50, 51 | 8.20 | 3.20 | 0.27 | 0.11 | 0.38 | |
| 58, 59 | 18.2 | 3.6 | 0.61 | 0.12 | 0.73 | |
| 60, 61 | 8.0 | 33.9 | 0.27 | 1.13 | 1.40 | X |
| 62, 63 | 18.9 | 27.9 | 0.68 | 0.93 | 1.61 | X |
| 70, 71 | 9.5 | 1.35 | 0.34 | 0.05 | 0.39 | |
| 74, 75 | 18.1 | 7.48 | 0.65 | 0.25 | 0.90 | |
| 76, 77 | 20.7 | 5.1 | 0.76 | 0.17 | 0.93 | |
| 1 | 39.4 | - | 1.31 | - | 1.31 | X |
| 2 | 37.0 | - | 1.24 | - | 1.24 | X |
| 3 | 24.1 | - | 0.80 | - | 0.80 | |
| 6 | 22.4 | - | 0.75 | - | 0.75 | |
| 24, 25 | 5.4 | - | 0.21 | - | 0.21 | |
| 26 | 4.9 | - | 0.16 | - | 0.16 | |
| 35, 36 | 7.4 | - | 0.36 | - | 0.36 | |
| 51, 52 | 9.3 | - | 0.45 | - | 0.45 | |
| 55, 56 | 16.2 | - | 0.54 | - | 0.54 | |

* See Figure 2 for member locations

** For the critical load combination

X Does not meet criteria

S. . BRIDGE : GROUP V-2 TABLE 2

/BLUME
ssie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 21

JOB S. F. Bridge BY CHC DATE 9/6/74

SUBJECT 4th St. Bridge - Results CHK'D DATE

Beam Elements

Model A - Beam elements for 78/79
B - Truss elements " "

| Member | Note | Gravity P | Gravity $V_{3-2}/V_{3-3}$ | Gravity $M_{3-2}$ | Gravity $M_{3-3}$ | EQ. Y P | EQ. Y $V_{3-2}/V_{3-3}$ | EQ. Y $M_{3-2}$ | EQ. Y $M_{3-3}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1, 2 | Transition post | -949 (731) | | ~ | 6211 (3261) | 284 | 361 | | 2470 |
| 3 4 | Truss post | -14 (230) | | | 3819 (1713) | 84 | / | | 2753 |
| 5 6 | " | -14 | | | | Model A | | | 2358 |
| 7, 8 | " | -13 | | | | Model B | | | 939 |
| 5 6 | | | | | | | | | |
| 7, 18 | | | | | | | | | |
| 14 | Frame Top Bm | | | | | | | | |
| 5, 13 | | | | | | | | | |
| 11, 12 | | | | | | | | | |
| 41, 45 | Frame Bottom Beam | | | | | | | | |
| 43, 44 | | | | | | | | | |
| 43 | | | | | | | | | |
| 1, 22 | CTW7 ARM | -766 (718) | | | | | | | |
| 29 | Floor Beam | | | | | | | | |
| 30, 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 33, 34 | | | | | | | | | |
| 5 | | | | | | | | | |
| 35, 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 6.47 | Truss Top | 22 (20) | | 15.5 (15) | - | 155 | | 12.9 | ~ |
| 49 ~ 51 | | 73 (70) | | 64.5 (61.9) | | 243 | | 246.0 | ~ |
| 53 ~ 55 | | 307 (300) | | 83.5 (209) | | 243 | | 152.0 | ~ |
| 6.57 | | 711 (701) | | 403 (479) | | 299 | | 345.0 | ~ |
| 6.59 | | 711 (701) | | 1,232 (1877) | | 299 | | 1302.0 | ~ |
| 6 61 | | 428 (425) | | 5491 (5678) | | 205 | | 2561.- | ~ |
| 6, 63 | Truss Bottom | -789 (784) | | 2,953 (2951) | | 312 | | 1354. | ~ |
| 6, 65 | | -173 (158) | | 41 (41.8) | | 121 | | 28. | ~ |
| 6.67 | | -17.3 | | 41 | | 121 | | 256. | ~ |
| 6 ~ 71 | | -167.6 (163) | | 123 (121) | | 234 | | 236 | ~ |
| 7 ~ 75 | | -482.0 (475) | | 263 (258) | | 230 | | 117 | ~ |
| 7 77 | | -866.0 (860) | | 900 (891) | | 338 | | 395 | ~ |

S/BLUME
ssie Street (at New Montgomery)
rancisco, California 94105

SHEET NO. 22

NO. JOB S. F. Bridge BY EKC DATE 8/2/84

SUBJECT 4th St. Bridge - Results CHK'D DATE

## Beam Elements

| Number | Note | EQ X | | | | EQ Z | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ | P | $V_{2-2}/V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ |
| 1, 2 | Trunnion post | 940. | 353/ | ~ | 47,990 | 529 (415) | 132/459 (505) | 22750 (23,260) | 7258 (5253) |
| 3, 4 | Tower post | 948 | 242/ | ~ | 56,780 | 8.1 (131) | | 768 (3575) | 5,555 (5,062) |
| 5, 6 | " | 4.1 | 228/ | ~ | 89,870 | 8.1 (37.1) | | 1630 (4,459) | 754 (1568) |
| 7, 8 | " | 4.1 | 228/ | ~ | 35,590 | 0.4 | | 1630 (4,459) | 754 (657) |
| 5, 16 | | | | | | 529 (415) | | 65,520 (71,900) | [illegible] (16,370) |
| 7, 18 | | | | | | 8.1 | | | |
| 9, 14 | Frame - Top Bm | 7.5 | | 321 | 30 | 16.5 | | 45 | 722 |
| 0, 13 | | | | | | 8.0 | | 27 | 38 |
| 1, 12 | | | | | | 1.9 | | | |
| 1, 45 | Frame - Bottom Bm | | | | | 13 | | | |
| 2, 44 | | | | | | 5.2 | | | |
| 43 | | | | | | | | | |
| 1, 22 | CTW7 APM | 109 | ~/107 | 10,260 | - | 458 (436) | 434/11.8 | 1130 (1029) | 4,550 (4,380) |
| 29 | Floor Beam | | | | | | | | |
| 0, 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 3, 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 6, 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 16, 47 | Truss Top | 54.8 | | ~ | ~ | 139 (130) | | 36.4 (36.1) | 1852 (945) |
| 8 ~ 51 | | 86.4 | | 54 | ~ | 220 (205) | | 109 (106) | 4413 (2251) |
| 2 ~ 55 | | 135.2 | | 144 | ~ | 424 (392) | | 200 (186) | 5884 (3751) |
| 6, 57 | | 164. | | 639 | ~ | 616 (565) | | 551 (530) | 8,825 (4501) |
| 8, 59 | | 164 | | 5495 | ~ | 616 (565) | | 2510 (2528) | 9618 (4906) |
| 0, 61 | | 118 | | 4,350 | ~ | 261 (245) | 448/59 | 4907 (4682) | 69590 (55,140) |
| 0, 63 | Truss - Bottom | 122 | | 738 | ~ | 481 (458) | | 258 (244) | 7457 (8630) |
| 4, 65 | | 43 | | 15 | ~ | 90 (87) | | 44 (43) | 97 (94) |
| 6, 67 | | 43 | | 51 | ~ | 90 (87) | | 100 (95) | 1040 (969) |
| 8 ~ 71 | | 108 | | 57 | ~ | 252 (241) | | 158 (140) | 1179 (1189) |
| 0 ~ 75 | | 156 | | 57 | ~ | 391 (372) | | 140 (161) | [illegible] (6928) |
| 2, 77 | | 132 | | 183 | ~ | 518 (449) | | 721 (678) | [illegible] (8928) |

S/BLUME
ssie Street (at New Montgomery)
rancisco, California 94105

SHEET NO. 23

JOB S. F. Bridge BY CKC DATE

SUBJECT 4th St. Bridge CHK'D DATE

Section properties - Beam Elements

| Member No. | Mat. No. | A | $I_{2-2}$ | $I_{3-3}$ | $S_{2-2}$ | $S_{3-3}$ | $r_{min}$ | $\ell$ | $K\ell/r$ | $F_a$ (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1, 2 | 1 | 69.2 | 2,232 | 13,500 | 298 | | 5.7 | 96 | 2×16.8 | 16.4 |
| 4 | 2 | 51.5 | 630 | 13,500 | 84 | | 3.5 | 96 | 2×27 | 15.0 |
| 6 | " | 51.5 | 630 | 9,023 | 84 | 530 | 3.5 | | | |
| 8 | " | | | | | | | | | |
| 14 | 3 | 16.7 | 3,047 | 12,189 | 226 | 451 | 13.5 | 110 | 8.1 | 17.8 |
| 13 | " | | | | | | | | | |
| 12 | " | | | | | | | | | |
| 4-5 | | | | | | | | | | |
| 44 | | | | | | | | | | |
| 23 | | | | | | | | | | |
| 22 | 7 | 57.2 | 967 | 2210 | 167 | 276 | 4.1 | 96 | 2×23 | 15.6 |
| 6.47 | 9 | 26.5 | 750 | 4,009 | 100 | 349 | 5.3 | 217 | 41.0 | 15.9 |
| 6-51 | 10 | 30.9 | 820 | 4,084 | 109 | 355 | 5.2 | 173 | 33.0 | 16.4 |
| 5-55 | 11 | 47.5 | 1126 | 6,269 | 150 | 545 | 4.9 | 173 | 35.0 | 16.3 |
| 6-57 | 12 | 59.5 | 1270 | 7,856 | 169 | 683 | 4.6 | 173 | 37.0 | 16.2 |
| 5-59 | 12 | " | " | " | " | " | " | 93 | 20 | 17.2 |
| 6.61 | 13 | 76.7 | 1,424 | 9,345 | 190 | 813 | 4.5 | 178 | 40 | 16.0 |
| 6.63 | 14 | 58.9 | 1,242 | 7,789 | 166 | 677 | 4.6 | 164 | 36 | 16.3 |
| 6.65 | 15 | 23.2 | 698 | 3,068 | 93 | 267 | 5.4 | 173 | 32 | 16.5 |
| 6.67 | 15 | " | " | " | " | " | " | " | " | " |
| 6.71 | 16 | 38.0 | 952 | 5,026 | 127 | 437 | 5.0 | 173 | 35 | 16.3 |
| 7-75 | 17 | 40.3 | 968 | 5,330 | 129 | 463 | 4.9 | 173 | 35 | 16.3 |
| 7-77 | 18 | 58.9 | 1242 | 7,789 | 166 | 677 | 4.6 | 177 | 38 | 16.1 |

Beam Elements

△/⊗ :

$M_{2-2} = 4,456/2 = 2,228$

$f_{2-2} = 2228/84 = 26.5$

$\frac{26.5}{30} = 0.88 < 1.0$

$P = -14 \pm (32 - 0.1 \times 5)/2$
$= -33$

$f_P = -33/51.5 = 0.64$

$f_P/F_a = \frac{0.64}{15} = 0.02$

0.10

$M_{3-3} = 84,870/2 = 42,435$ k-in
EQ. X

$f_{3-3} = 42,435/530 = 80$

$\frac{80}{30} = 2.66 >> 1.0$ N.G.

△/⊗ :

$M_{3-3} = (35,590 + 0.67 \times 2238)/2$
EQ X
$= 18,544$

$f_{3-3} = 18,544/531 = 35$

$\frac{35}{30} = 1.17 > 1.0$ N.G.

△/⊗ :

$P = -731 \pm (940 + 0.3 \times 415)/2$
I 532
$= -1263$ k

$f_P = -1263/69.2 = -18.2$ ksi

$M_{2-2} = 25,260/2 = 12,630$ k-in

$f_{2-2} = 12,630/298 = 42$ ksi

$\frac{18.2}{1.7 \times 16.4} + \frac{42}{30} = 0.65 + 1.41 = 2.05 > 1.6$ N.G.

Beam Elements

△/△

$M_{3-3} = (47990 + 58750)/2 + (3261 + 1713)$

F.Q. × D.L.

$= 52,385 + 4974 = 57,359$ k-in

$f_{3-3} = 57,359/793 = 72.3$ ksi

$S_{3-3}$ - composite section.

$\frac{18.2}{1.7 \times 19.7} + \frac{73.2}{30} = 0.54 + 2.44 = 3.0 > 1.0$

N.G.

or

$M_{3-3} = 3261 + 47,990/2$

$= 27,256$

$I_{3-3} = 13,500$

$S_{3-3} = 13,500/17 = 793$

$f_{3-3} = 27,256/793 = 34$ ksi

$\frac{18.2}{1.7 \times 19.7} + \frac{34}{30} = 0.54 + 1.13 = 1.67 > 1.0$

N.G

△/△ :

$P = -230 \pm (948 + 0.3 \times 131)/2$ (±494)

$= -723$ k

$f_P = -723/51.5 = 14.05$ ksi

$M_{2-2} = 3575/2 = 1788$

$f_{2-2} = 1788/84 = 21.3$ ksi

$\frac{14.05}{1.7 \times 15} + \frac{21.3}{30} = 0.52 + 0.71 = 1.23 > 1.0$

N.G

Beam Elements

4A (4.) :

$$D = 20 \pm (130 + 0.67 \times 155)/2$$

EQ Z EQ Y ± 117

$$= -97 \text{ or } 137$$

$$f_T = \frac{97}{26.5} = -3.7 \text{ ksi}$$

$$M_{3-3} = 945/2 = 473$$

EQ. Z

$$f_{3-3} = \frac{473}{34.9} = 1.35$$

$$\frac{3.7}{1.7 \times 45.9} + \frac{1.35}{30} = 0.39 + 0.05 = 0.44 < 1.0$$

OK

4A ~ 6A :

$$P = 70 \pm (205 + 0.67 \times 243)/2$$

EQ Z EQ Y ± 184

$$= 254$$

$$f_P = 254/30.9 = 8.2 \text{ ksi}$$

$$M_{3-3} = 0 + 2251/2$$

EQ. Z

$$= 1126$$

$$f_{3-3} = 1126/355 = 3.2$$

$$\frac{8.2}{30} + \frac{3.2}{30} = 0.27 + 0.11 = 0.38 < 1.0$$

6A / 6A :

$$P = 701 \pm (565 + 0.67 \times 299)/2$$

EQ. Z EQ Y ± 382

$$= 1083$$

$$f_P = 1083/59.5 = 18.2$$

$$M_{3-3} = 4501/2 = 2251$$

$$f_{3-3} = 2251/683 = 3.3$$

$$(18.2 + 3.3)/30 = 0.72 < 1.0 \quad \text{O.K.}$$

Beam Elements

3/6A :

$$P = 701 \pm (565 + 0.67 \times 2993)/2 \quad (\pm 303)$$

EQ. Z EQY

$= 1083$

$f_p = 1083/59.5 = 18.2$

$M_{3-3} = 4906/2 = 2453$

$f_{3-3} = 2453/683 = 3.6$

$\frac{18.2 + 3.6}{30} = 0.73 < 1.0$ o.k.

3/6A :

$P = 425 \pm (248 + 0.67 \times 2051/2$

EQZ EQY

$= 617$ or $553$ --- $Z = 3.0$

$f_p = 617/76.7 = 8.0$ ksi or $7.2$

$M_{3-3} = 55{,}140/2$

$= 27{,}570$ or $18{,}380$ -- $Z = 3.0$

$f_{3-3} = 27{,}570/813$ or $22.6$

$= 33.9$

$\frac{8.0}{30} + \frac{33.9}{30} = 1.40 \leftarrow Z = 2.0$

$\frac{7.2}{30} + \frac{22.6}{30} = 29.8/30 = 0.99 \leftarrow Z = 3.0$

o.k.

$\therefore$ $Z = 3.0$ for Girder or beam

## Beam Elements

63 / 63 :

$$P = .784 \pm (458 + 0.67 \times 312)/2 \pm 335$$

EQ Z EQ Y

$$= -1117 \text{ K}$$

$$f_P = \frac{1117}{58.9} = -18.9$$

$$M_{33} = 8830/2$$

$$= 4416$$

$$f_{3-3} = 4416/677 = 6.5$$

$$\frac{18.9}{1.7 \times 16.3} + \frac{6.5}{30} = 0.68 + 0.22 = .9 < 1.0$$

o.k.

$$M_{2-2} = 2951 + (2424 + 0.67 \times 1294)/2$$

D.L EQ Z EQ Y

$$= 4630$$

$$f_{2-2} = 4630/166 = 27.9 \text{ ksi}$$

$$\frac{18.9}{1.7 \times 16.3} + \frac{27.9}{30} = 0.68 + .93 = 1.61 > 1.0$$

if $Z = 3.0$

$$\frac{17.1}{1.7 \times 16.3} + \frac{24.3}{30} = 0.62 + 0.82 > 1.0$$

N.G.

Beam Elements

(6) - (7) :

$$P = -16.3 \pm (241 + 0.67 \times 234)/2$$
EQZ EQY

$$= -302$$

$$f = 302/38 = -9.5 \text{ ksi}$$

$$M_{3-3} = 1183/2 = 592$$

$$f_{3-3} = 592/437 = 1.35$$

$$\frac{9.5}{1.7 \times 16.3} + \frac{1.35}{30} = 0.34 + 0.05 = 0.39 < 1.0$$

O.K

(7) - (8) :

$$P = -475 \pm (372 + 0.67 \times 230)/2$$
EQZ

$$= -738$$

$$f = 738/40.8 = 18.1 \text{ ksi}$$

$$M_{3-3} = 6928/2 = 3464$$

$$f_{3-3} = 3,464/463 = 7.48$$

$$\frac{18.1}{1.7 \times 16.3} + \frac{7.48}{30} = 0.65 + 0.25 = 0.9 < 1.0$$

O.K.

(8) - (9) :

$$P = -860 \pm (493 + 0.67 \times 338)/2$$
EQZ

$$= 1,220$$

$$f = 1220/58.9 = 20.7$$

$$M_{3-3} = 6928/2 = 3,464$$

$$f_{3-3} = 3464/677 = 5.1$$

$$\frac{20.7}{1.7 \times 16.1} + \frac{5.1}{30} = 0.76 + 0.17 = 0.93 < 1.0$$

O.K

FS/BLUME
Bessie Street (at New Montgomery)
n Francisco, California 94105

SHEET NO. 30

JOB S. F. Bridge BY CKK DATE 9/6/24

SUBJECT 4th st. Bridge - Results CHK'D DATE

## Truss Elements

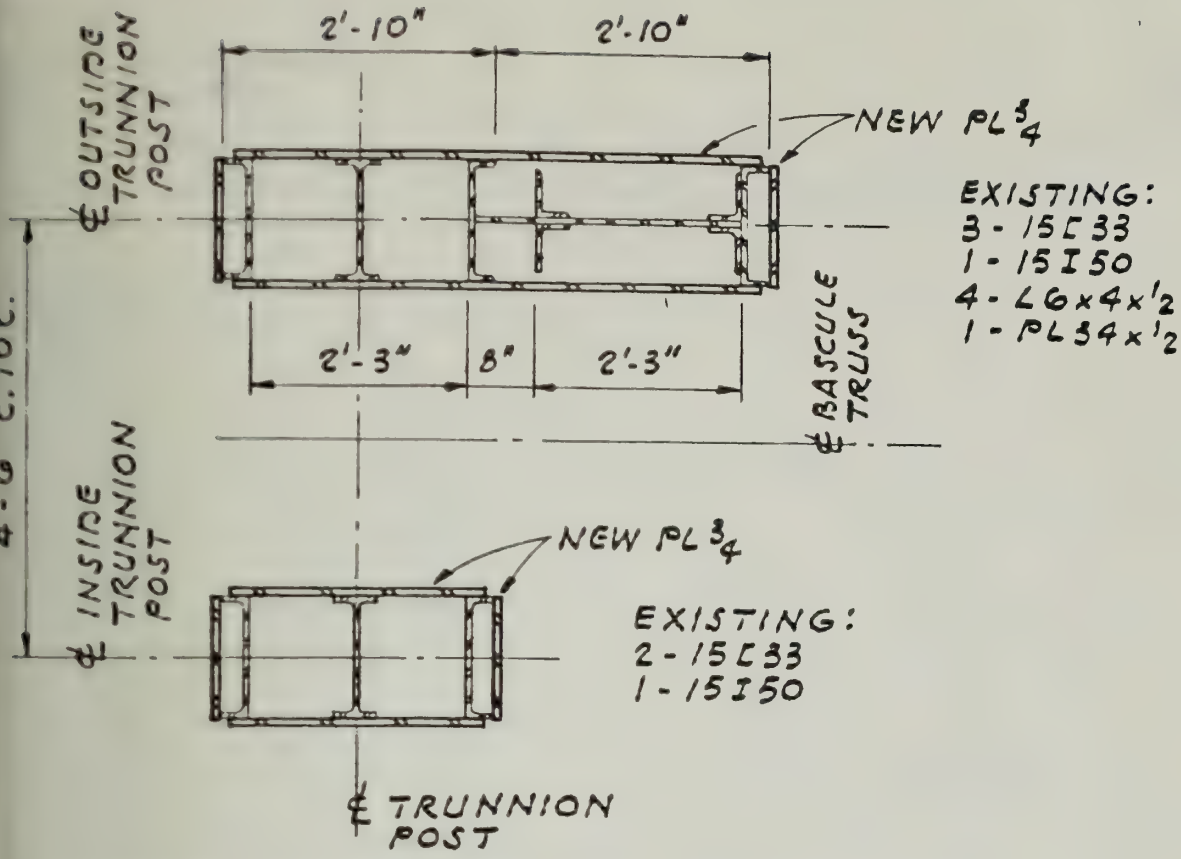
| Member | A | Note | Gravity P | EQ.X P | EQ.Y P | EQ.Z P |
|---|---|---|---|---|---|---|
| 1, 59 | 2.86 | Floor Bracing | -0.6 | 1.4 | 4.1 | 116 (110) |
| 2, 60 | | | -0.6 | 1.4 | 4.1 | 108 (104) |
| 3, 61 | | | -3.4 (-3.3) | 2.2 | 4.8 | 73 (60) |
| 4, 62 | | | -3.4 | 2.2 | 4.8 | 60 (53) |
| 5, 63 | | | -9.5 (9.3) | 2.6 | 4.5 | 42 (32) |
| 6, 9 | | | -9.5 | 2.6 | 4.5 | 70 (61) |
| 10, 11 | 8.4 | Tower Bracing | | | | 7.6, 10.4 |
| 12, 13 | | | | | | 4.5, 5.9 |
| 14, 15 | | | | | | 4.6, 4.6 |
| 16, 17 | | | | | | 5.9 4.5 |
| 18, 19 | | | | | | 10.4, 7.6 |
| 20~23 | | | | | | 1.4 |
| 24 | 20 | CTWT Link | | 212 | 2.4 | 4.2 (9.4) |
| 25 | " | | | 212 | 2.4 | 4.2 (9.4) |
| 26, 27 | 4.2 | CTWT Truss | | 8.8 | | 4.2, 2.2 (18) |
| 28, 29 | " | | | 8.8 | | 2.2, 4.2 |
| 30 | " | | | 3.8 | | ~ |
| 33, 34 | 14.12 | Bascule Truss | 29.4 (29.4) | ~ | | 0.60 (.6) |
| 35, 36 | 24.7 | | -70.3 (68.3) | 54.2 | 151.0 | 138 (128) |
| 37, 38 | 10.24 | | 0.4 ( | ~ | ~ | 1.2 (1.4) |
| 39, 40 | 21.74 | | 120.8 (119) | 32.9 | 41.5 | 130 (119) |
| 41, 42 | 14.12 | | 31.6 (31.6) | ~ | | 1.3 (1.3) |
| 43, 44 | 27.1 | | -173.4 (171) | 31.9 | 85.7 | 128 (117) |
| 45, 46 | 10.2 | | ~ | ~ | | 1.9 (1.8) |
| 47, 48 | 32.74 | | 227.0 (225) | 25.3 | 155.3 | 124 (112) |
| 49, 50 | " | | 33.5 (33.6) | ~ | | 1.3 (1.3) |
| 51, 52 | 41.5 | | -281.0 (279) | 28.8 | 157.0 | 119 (107) |
| 53, 54 | " | | -18.6 (27) | 70.4 | 17.4 | 35 (33) |
| 55, 56 | 70.67 | | 814. (809) | 124.1 | 312.0 | 487 (463) |
| 57, 58 | 38.02 | | 268. (277) | 71.9 | 125.0 | 127 (117) |

Truss Elements

Z = 2.0

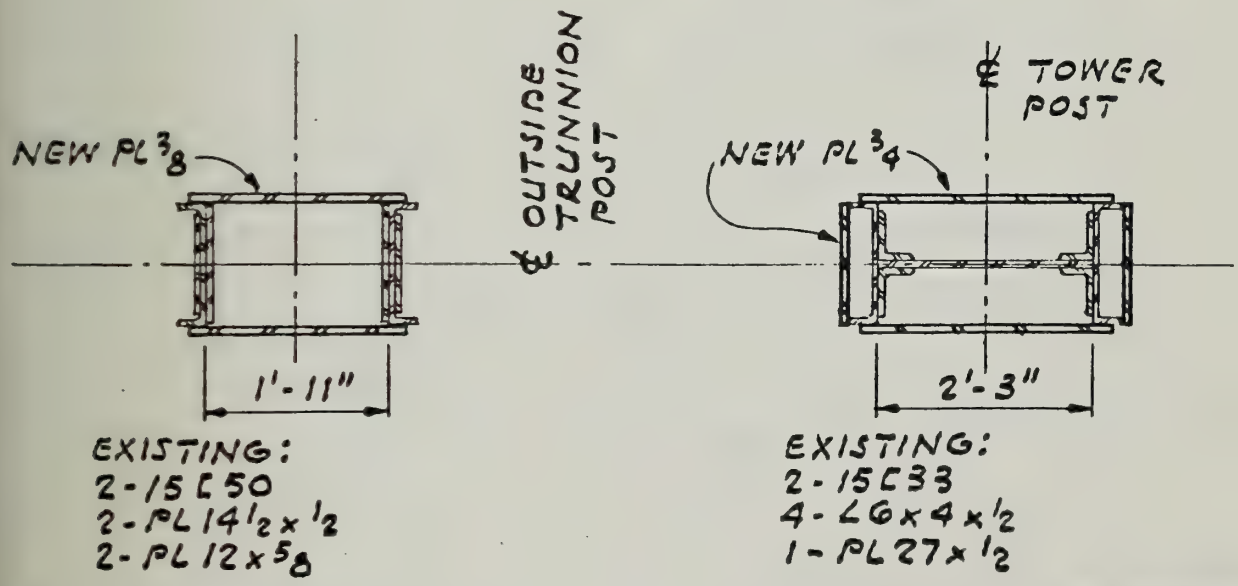
| ember | A | 1.7 Fa | Combined Axial P | fa = P/A | fa/1.7Fa |
|---|---|---|---|---|---|
| 1.59 | 2.86 | 30 - Tension only | 2(110 + 0.67×4.1)/2 = 113 | 39.4 | 1.31 |
| 2.60 | | | 2(104 + 0.67×4.1)/2 = 107 | 37.0 | 1.24 |
| 3.61 | | | 2(86 + 0.67×4.8)/2 = 69 | 24.1 | 0.80 |
| 4.62 | | | | | |
| 5.63 | | | | | |
| 6.9 | | | 2(61 + 0.67×4.5)/2 = 64 | 22.4 | 0.75 |
| 0.11 | 8.4 | 30 - Tension only | | | |
| 2.13 | | | | | |
| 4.15 | | | | | |
| 6.17 | | | | | |
| 8.19 | | | | | |
| 0-23 | | | | | |
| 24 | 20 | 1.7×14.8 | (212 + 0.3×94)/2 = ±215/2 = 107 | 5.4 | 0.21 |
| 25 | | = 25.2 | | | |
| 6.27 | 4.2 | 30 | 2(18 + 0.3×88)/2 = 20.6 | 4.9 | 0.16 |
| 8.29 | | | | | |
| 30 | | | | | |
| 3.34 | | | | | |
| 5.36 | 24.7 | $\frac{1.7}{1.33}$ × 16.3* = 20.8 | -68.3 ± (128 + 0.67×151)/2 = -183 | 7.4 | 0.36 |
| 7.38 | | | | | |
| 9.40 | 21.74 | 30 | 119 ± (119 + 0.67×41.5)/2 = +192 | 8.9 | 0.30 |
| 1.42 | | | | | |
| 3.44 | 27.1 | $\frac{1.7}{1.33}$ × 16.3 = 20.8 | -173.4 ± (117 + 0.67×85.7)/2 = -261 | 9.6 | 0.46 |
| 5.46 | | | | | |
| 7.48 | 32.74 | 30 | 225 ± (112 + 0.67×155.3)/2 = 333 | 10.2 | 0.34 |
| 9.50 | | | | | |
| 1.52 | 41.5 | 20.8 | -279 ± (107 + 0.67×157)/2 = -385 | 9.3 | 0.45 |
| 3.54 | | | | | |
| 5.56 | 70.67 | 30. | 809 ± (463 + 0.67×312)/2 = 1,145 | 16.2 | 0.54 |
| 7.58 | 38.02 | | 277 ± (117 + 0.67×125)/2 = 377 | 9.9 | 0.33 |

* From Drawing # 1372




TOWER SECTION BELOW TRUNNION

(MEMBERS 1 THRU 4)




SECTION OF MEMBERS

(MEMBERS 62 & 63)

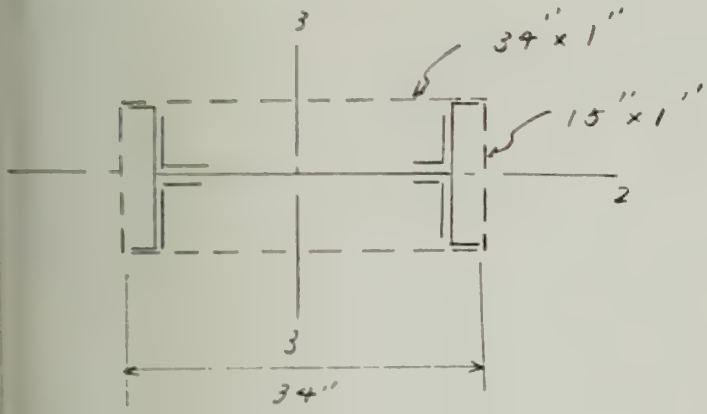
TOWER SECTION ABOVE TRUNNION

(MEMBERS 5 THRU 8)

STRUCTURAL MODIFICATIONS

..F. BRIDGE - GROUP V-2 FIGURE 3

Elements 5, 6, 7, 8 :




$\Delta I_{3-3} = \frac{2}{12} \times 34^3 + 2 \times 15 \times 17^2$

$= 6{,}551 + 8{,}670 = 15{,}221$

$\Sigma I_{3-3} = 15{,}221 + 9{,}023 = 24{,}244$

$S_{3-3} = 1426$

$\Delta I_{2-2} = \frac{2}{12} \times 15^3 + 2 \times 34 \times 7.5^2$

$= 563 + 3{,}825 = 4{,}388$

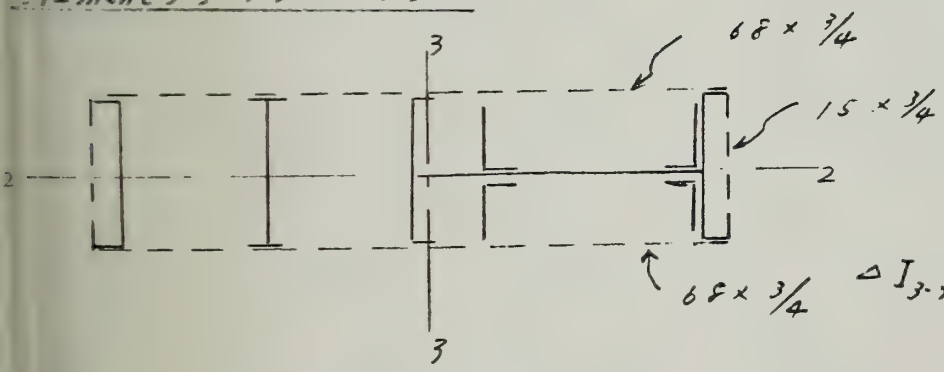
$\Sigma I_{2-2} = 4388 + 630 = 5{,}018$

$S_{2-2} = 669$

$\Delta A = 98$

$\Sigma A = 98 + 51.5 = 150$

Elements 1, 2, 3, 4




$\Delta A = 124.5$

$\Sigma A = 124.5 + 70.7$

$= 195.2$

$\Delta I_{3-3} = \left[\frac{1}{12} \times 2 \times 68^3 + 30 \times 34^2\right] \times \frac{2}{12}$

$= 65{,}313$

$\Sigma I_{3-3} = 65{,}313 + 26{,}962$

$= 92{,}275$

$S_{3-3} = 2{,}714$

$\Delta I_{2-2} = \left[\frac{2}{12} \times 15^3 + 68 \times 2 \times 7.5^2\right] \times \frac{2}{12}$

$= 6160$

$\Sigma I_{2-2} = 6160 + 1431 = 7591$

$S_{2-2} = 1012$

S/BLUME
asie Street (at New Montgomery)
Francisco, California 94105

SHEET NO. 3T

NO. JOB S. F. Bridge BY CKC DATE 9/7/84

SUBJECT 4th St. Bridge - Modification CHK'D DATE

Beam Elements

△/△ -

$M_{3-3} = (55{,}500 + 55{,}080)/Z + 0.6\,(49{,}750)$
EQ. X — Ass. No change

$= 60{,}264$ K-in

$f_{3-3} = 60{,}264 / 2714 = 22.2$ ksi

$P = -(731 + 230) \pm [1282 + 1282 + 0.3(281 + 254)]/Z$ (± 1362)

$= -2{,}323$ K.

$f_p = \dfrac{2323}{195.2} = 11.9$

$\dfrac{11.9}{1.7 \times 16.4} + \dfrac{22.2}{36} = 0.42 + 0.61 = 1.03$ O.K

△/△ -

$M_{3-3} = 109{,}500/Z = 54{,}750$

$f_{3-3} = 54{,}750/1426 = 38$ ksi

$38/36 = 1.05 \simeq 1.0$ say O.K.

△/△ -

$M_{3-3} = 45{,}930/Z = 22{,}965$

$f_{3-3} = 22{,}965/1426 = 16.1$ ksi O.K.

use 1/2" Rs instead of 1"

2/5

$$M_{2-2} = (30{,}420 + 13{,}830)/2$$

$$= 22{,}125$$

$$f_{2-2} = 22125/1012 = 21.9$$

$$0.36 + \frac{21.9}{30} = 0.36 + 0.61 = 0.97 < 1.0$$

↑ use

o.k.

Beam Elements

60 / 61 :

$$P = 425 \pm (\underset{EQ.Z}{193} + \overset{\pm 165}{\underset{EQ\,Y}{0.67 \times 193}})/2$$

$$= 590$$

$$f_p = 590/76.7 = 7.7 \text{ ksi}$$

$$M_{3-3} = 34{,}800/2 = 17{,}400$$

$$f_{3-3} = 17{,}400/813 = 21.4 \text{ ksi}$$

$$\frac{7.7 + 21.4}{30} = 0.97 < 1.0 \quad \text{O.K}$$

62 / 63 :

$$P = \underset{D.L.}{-784} \pm (\underset{EQ.Z}{358} + \overset{\pm 297}{\underset{EQ\,Y}{0.67 \times 350}})/2$$

$$= -1081$$

$$f_p = \frac{1080}{58.9} = 18.3$$

$$M_{2-2} = \underset{D.L}{2851} + (\underset{EQ\,Z}{1877} + \underset{EQ\,Y}{0.67 \times 1694})/2$$

$$= 3836 \quad , \quad f_{2-2} = 23.1$$

$$\frac{18.1}{1.7 \times 16.3} + \frac{23.1}{30} = 0.65 + 0.77 = 1.42 > 1.0$$

N.G.

$$M_{3-3} = \nearrow^{0} + (\underset{EQ\,Z}{8234} + \nearrow^{0})/2$$

$$= 4117 \text{ k-in}$$

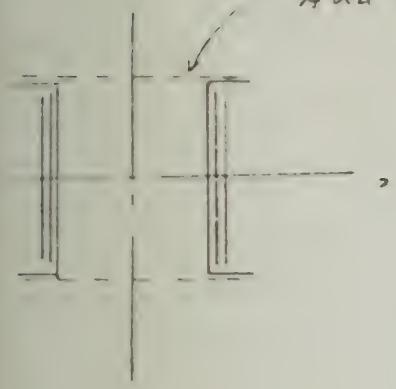
$$f_{3-3} = 4{,}117/677 = 6.08$$

$$0.65 + \frac{6.08}{30} = 0.65 + 0.20 = 0.85 < 1.0$$

O.K

modified scheme for Members 62 & 63

Add 2 3 x 3/8 steel PLs top & bottom



$\Delta I_{2-2} = 2 \times 8.6 \times 7.5^2 = 968$

$I_{2-2} = 968 + 1242$

$= 2210$

$S_{2-2} = 2210/7.5 = 295$

$M_{2-2} = 3836$

$f_{2-2} = 3836/295 = 13.0$ ksi

$0.65 + \frac{13.0}{36} = \cancel{0.65}\ 0.51 + 0.36$

$= 1.01$ say OK
$(0.87)$

$f_p = \frac{1080}{75.2} = 14.2$

$f_p / 1.7 \times 16.3 = 0.51$

Beam Elements

△2-△2 : $P = -475 \pm (290 + 0.67 \times 280)/Z$ (3239; EQZ, EQY)

$= -714$

$f = 714/41.8 = -17.5$ ksi

$M_{3-3} = 6791/Z = 3396$

$f_{3-3} = 3396/463 = 7.3$

$\frac{17.5}{1.7 \times 16.3} + \frac{7.3}{30} = 0.63 + 0.24 = 0.87 < 1.0$

$M_{2-2} = 101$

△1-△1 : $P = -860 \pm (387 + 0.67 \times 378)/Z$ (+320; EQZ, EQY)

$= -1180$

$f = 1180/58.9 = 20.0$

$M_{3-3} = 6791/Z = 3396$

$f_{3-3} = 3396/677 = 5.0$

$\frac{20}{1.7 \times 16.1} + \frac{5.0}{3.0} = 0.73 + 0.17 = 0.95 < 1.0$ O.K.

$M_{2-2} = (526 + 0.67 \times 470)/Z$ (EQZ)

$= 420$

$f_{2-2} = 420/166 = 2.5$

$0.73 + \frac{2.5}{30} = 0.73 + 0.08 = 0.81 < 1.0$ O.K.

## Truss Elements

Floor Bracing :

① / (59) -

$P = 2 \times 106/2 = 106$

$f = 106/2.81 = 37$ ksi $> 30$ ksi

② / (50) - $P = 99$

$f = 99/2.86 = 34.6$ ksi $> 30$ ksi

③ / (51) - $P = 59$

$f = 59/2.86 = 20.6$ ksi $< 30$ ksi
O.K

∴ Truss elements ①, ②, (50), (51)
Need modification.

(24) / (55) - $P = -1.6 - (275 + 0.3 \times 34.2)/2$
Link EQX EQZ

$= -144$

$f = \frac{144}{20} = 7.2/25.2 = 0.29 < 1.0$ O.K

CTWT Bracing - tension in action only.
(26) ~ (29)

$P = (67 + 80.1)/2 = 73.55$

$f = 73.55/4.2 = 17.5$ ksi

$17.5/30 = 0.58 < 1.0$ O.K.

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

SHEET NO. 40

JOB S. F. Bridge BY CKC DATE 1-/31/84

SUBJECT 4th Bridge - Cost Estimate CHK'D DATE

Tower below trunnion

3/4" PL

$A = [(5.5 \times 2 + 1.25 \times 2) + (2.75 \times 2 + 1.25 \times 2)]$

$= (11 + 2.5 + 5.5 + 2.5) \times 16$

$= 344 \text{ ft}^2$

$Vol. = 344 \times 3/4 \times \frac{1}{12} = 22 \text{ ft}^3$

Tower above trunnion

3/4" PL

$A = [(2.5 \times 2) + (1.25 \times 2)] \times 31$

$= 232.5$

$Vol = 232.5 \times \frac{3}{4} \times \frac{1}{12} = 14.5 \text{ ft}^3$

Element 62

3/8" PL

$A = (2 \times 2) \times 15 = 60 \text{ ft}^2$

$Vol = 60 \times \frac{3}{8} \times \frac{1}{12} = 1.9 \text{ ft}^3$

Diagonals

L 4 x 4 x 3/8

9.8 #/ft

$\ell = \sqrt{46^2 + 28^2} = 53.9 \text{ ft}$

$2 \times 53.9 \times 9.8 = 1056 \text{ lbs}$

Total steel

$1056 + (22 + 14.5 + 1.9) \times 2 \times 490$

$= 1056 + 37,632 = 38,688 \text{ lbs}$

Welding

length = 16 × 16 × 2 ... below Trunnion

8 × 31 × 2 ... above "

4 × 15 × 2 -- Elements 62, 63

= 512 + 496 + 120

= 1128 ft

/BLUME
sie Street (at New Montgomery)
ancisco, California 94105

SHEET NO.

| | | | |
|---|---|---|---|
| JOB | S. F. Bridges | BY | DATE |
| SUBJECT | Islais Creek Bridge | CHK'D | DATE |

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2. Member properties & Masses ----- 2-12

3. Evaluation - closed position ----- 13-21

4. Evaluation - open position ----- 22-27

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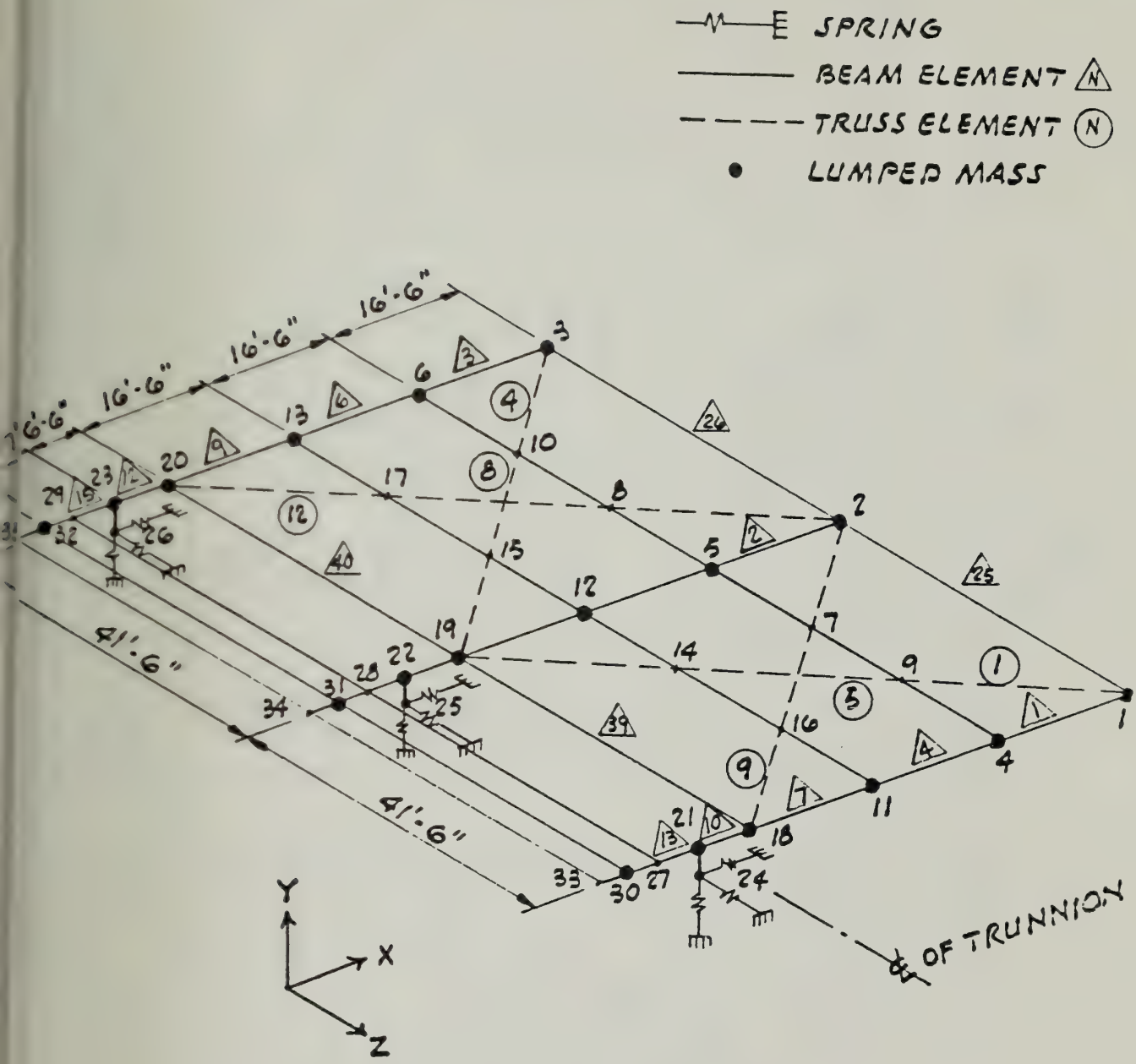



MATHEMATICAL MODEL

3RD ST. OVER ISLAIS CREEK

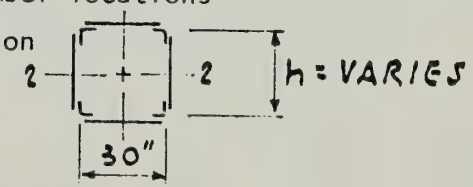
E. BRIDGE : GROUP V-3 FIGURE 2

Section Properties 3rd Street Bridge Over Tsiats Creek

| Member* I.D. | Nodal* Points | A (in.$^2$) | $S_{2-2}$ (in.$^3$) | $S_{3-3}$ (in.$^3$) | Section ** |
|---|---|---|---|---|---|
| 1, 3 | 1-4, 3-6 | 125 | 2760 | 1510 | 4-L 8 x 6 x 1/2, 2 -1/2 WEB, 2-3/8 T&B |
| 2 | 2 - 5 | 144 | 3422 | 1718 | 4-L 8 x 6 x 7/8, 2-1/2 WEB, 2 - 3/8 T&B |
| 4, 6 | 4-11, 6-13 | 130 | 3208 | 1584 | Same as members 1 & 3, except height |
| 5 | 5 - 12 | 152 | 3833 | 1905 | 4-L 8 x 6 x 1, 2-1/2 WEB, 2-3/8 T&B |
| 7, 9 | 11-18,13-20 | 165 | 5317 | 2024 | 4-L 8 x 8 x 7/8, 2-1/2 WEB, 2-3/8 T&B |
| 8 | 12 - 19 | 217 | 6019 | 2757 | 2-L 8x6x1, 4-L 8x4x1, 2-1/2 WEB, 2-3/4 T&B |
| 10, 12 | 18-21,20-23 | 229 | 7298 | 3064 | 2-L 8x8x7/8, 4-L 8x4x1, 2-1/2 WEB 2-3/4 T&B |
| 11 | 19 - 22 | 240 | 8206 | 3101 | 2-L 8x6x1, 4-L 8x4x1, 2-1/2 WEB, 2-3/4 T&B |
| 13, 15 | 21-27,23-29 | 229 | 7298 | 3064 | Same as members 10 & 12 (assumed) |
| 14 | 22 - 28 | 240 | 8206 | 3101 | Same as member 11 (assumed) |
| 25, 26<br>39, 40 | 1 -2-3<br>18-19-20 | 44.8 | 487 | 47 | W 33 x 152 |
| 27 ∿ 32<br>33 ∿ 38 | 4-5-6<br>11-12-13 | 57.2 | 669 | 62 | W 36 x 194 |
| 1 ~ 4 | - | 2.13 | - | - | C 4 x 7.25 |
| 5 ~ 8 | - | 2.86 | - | - | L 5 x 3 x 3/8 |
| 9 ~ 12 | - | 3.61 | - | - | L 6 x 4 x 3/8 |

* See Figure 2 for member locations

** Typical girder Section

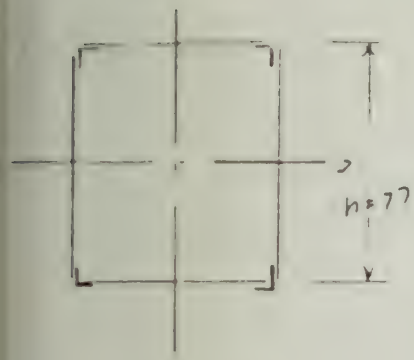



S.F. BRIDGE : GROUP V-3

TABLE 1

## Member properties

2 S :




4-L 8 × 6 × 7/8 , A = 11.5 , $\bar{x}$ = 1.61, $\bar{y}$ = 2.61

Top PL - 30 × 3/8 , A = 11.25

Bottom PL - 26 × 3/8 , A = 9.75

Web PL - 77 × 1/2 , A = 38.5

$\Sigma A = 4 \times 11.5 + 11.25 + 9.75 + 2 \times 38.5$
$= 144 \text{ in}^2$

$w = 4.95$ PLF

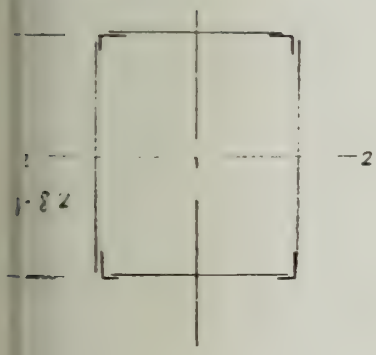
$S_{2-2} = 3422$

$I_{2-2} = 4 \times 11.5 \times (38.5 - 1.61)^2 + 11.25 \times 38.5^2 + 9.75 \times 38.5^2 + \frac{1}{12} \times 77^3$
$= 62,600 + 31,127 + 38,044 = 131,771$

$S_{3-3} = 1718$

$I_{3-3} = 4 \times 11.5 \times (15 - 2.61)^2 + 2 \times 38.5 \times (15)^2 + 844 + 549$
$= 25,780$

5-12 :




Top : L 8 × 6 × 1 , A = 13.0 , $\bar{x}$ = 1.65, $\bar{y}$ = 2.65

PL - 30 × 3/8 A = 11.25

Bottom : L 8 × 6 × 7/8 A = 11.5 , $\bar{x}$ = 1.61 , $\bar{y}$ = 2.61

PL - 26 × 3/8 A = 9.75

Web : PL - 1/2 × 82 A = 41

$\Sigma A = 2 \times 13 + 11.5 + 2 \times 11.5 + 9.75 + 82$
$= 152 \text{ in}^2$

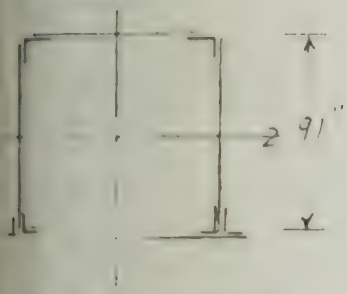
$w = 522$ PLF

$I_{2-2} = 26 \times (41 - 1.65)^2 + 2 \times 3 \times (41 - 1.61)^2 + \frac{1}{12} \times 82^3 + 11.5 \times 41^2 + 9.75 \times 41^2$
$= 40,259 + 35,686 + 45,947 + 18,911 + 16,389$
$= 157,192$

$I_{3-3} = 2 \times 13 \times (30/2 - 2.65)^2 + 2 \times 11.5 \times (15 - 2.61)^2 + 844 + 549 + 82 \times 15^2 = 8733 + 844 + 549 + 18,450 = 28,576$

Member properties

12-19




Top: $2\angle 8 \times 6 \times 1$, $A = 13$, $\bar{x} = 1.65$, $\bar{y} = 2.65$

$\square\ 30 \times 3/4$, $A = 22.5$.

Bottom: $2\angle 8 \times 4 \times 1$, $A = 22$, $\bar{x} = 1.05$

$\square\ 44 \times 3/4$ $A = 33$

Web: $1/2 \times 91$ $A = 45.5$

$$\bar{x} = \frac{26 \times (91 - 1.65) + 22.5 \times 91 + 91 \times 45.5}{26 + 22.5 + 44 + 33 + 91}$$

$$= \frac{2323 + 2048 + 4140}{216.5} = 39.3 \approx 40$$

$w = 734$ PLF

$$I_{2-2} = \underbrace{26 \times (51.0 - 1.65)^2}_{63320} + \underbrace{22.5 \times 51.^2}_{58522} + \underbrace{\tfrac{1}{12} \times 91^3}_{62797}$$
$$+ \underbrace{91 \times (45.5 - 40)^2}_{2753} + \underbrace{44 \times (40.0 - 1.05)^2}_{66752}$$
$$+ \underbrace{33 \times 40.^2}_{52800}$$
$$= 306944 \text{ in}^4 \qquad S_{2-2} = 6019 \text{ in}^3 \leftarrow$$

$$I_{3-3} = \underbrace{26 \times (15 - 2.65)^2}_{3986} + \underbrace{\tfrac{1}{12} \times 26^3 \times 3/4}_{1686} + \underbrace{44 \times (15)^2}_{9900}$$
$$+ \underbrace{91 \times 15^2}_{20475} + \underbrace{\tfrac{1}{12} \times 44^3 \times 3/4}_{5324}$$
$$= 41353 \text{ in}^4$$

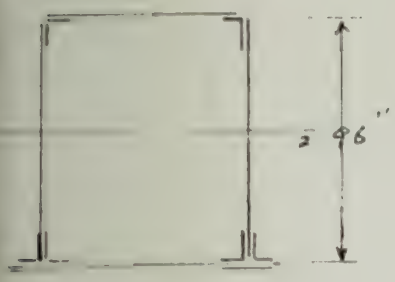
If $\bar{x} = 45.5$

$$I_{2-2} = \underbrace{26 \times (45.5 - 1.65)^2}_{49993} + \underbrace{22.5 \times 45.5^2}_{46580} + \underbrace{\tfrac{1}{12} \times 91^3}_{62797}$$
$$+ \underbrace{44 \times (45.5 - 1.05)^2}_{86935} + \underbrace{22.5 \times 45.5^2}_{46580}$$
$$+ \underbrace{30 \times 45.5^2}_{62108}$$
$$= 354993$$

$$S_{2-2} = 7802 \leftarrow$$

## Member properties

19-22 / 22-28 :




Top : $2L\ 8 \times 6 \times 1$, $A = 13$, $\bar{x} = 1.65$, $\bar{y} = 2.65$

$PL\ 30 \times 3/4$ $A = 22.5$

Bottom : $2L\ 8 \times 4 \times 1$ $A = 22$, $\bar{x} = 1.05$

$PL\ 44 \times 3/4$ $A = 33$

$PL\ 12 \times 3/4$ $A = 9$

Web : $1/2 \times 96$ $A = 48$

$$\Sigma A = 2 \times 13 + 22.5 + 2 \times 22 + 33 + 2 \times 9 + 96$$

$$= 239.5$$

$$w = 823 \text{ PLF}$$

$$\bar{x} = \frac{26 \times (96 - 1.65) + 22.5 \times (96) + 96 \times 48}{239.5}$$

$$= \frac{2453 + 2160 + 4608}{239.5} = 38.5$$

$$I_{2\text{-}2} = \underbrace{2 \times 18 \times (57.5 - 1.65)^2}_{99{,}815} + \underbrace{22.5 \times 57.5^2}_{74{,}390}$$

$$+ \underbrace{96 \times (57.5 - 48)^2}_{8664} + \underbrace{\frac{1}{12} \times 96^3}_{73{,}728}$$

$$+ \underbrace{44 \times (38.5 - 1.05)^2}_{61{,}710} + \underbrace{33 \times 38.5^2}_{75{,}595} + 18 \times 38.5$$

$$= 393{,}905$$

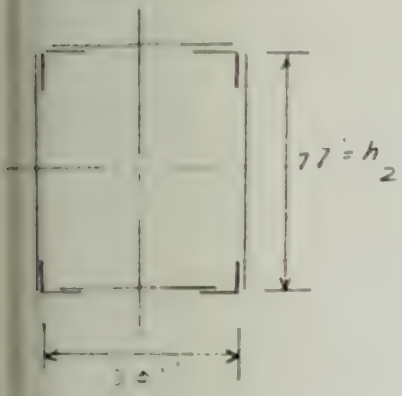
$$I_{3\text{-}3} = \underbrace{26 \times (15 - 2.65)^2}_{3{,}966} + \underbrace{\frac{1}{12} \times 30^3 \times 3/4}_{1688} + \underbrace{2 \times 22 \times 15}_{9900}$$

$$+ \underbrace{96 \times 15^2}_{21{,}600} + \underbrace{\frac{1}{12} \times 44^3 \times 3/4}_{5324} + \underbrace{2 \times 9 \times 15^2}_{4050}$$

$$= 46{,}528$$

## Member properties

1-4 / 3-6 :




$\angle 8 \times 6 \times 1/2$ . Top PL - $30 \times 3/8$ , $A = 11.25$

$A = 6.75$

$\bar{x} = 1.47$ Bottom PL - $26 \times 3/8$ , $A = 9.75$

$\bar{y} = 2.47$ Web PL - $1/2$ , $A = 38.5$

$\Sigma A = 4 \times 6.75 + 11.25 + 9.75 + 2 \times 38.5$

$= 27 + 11.25 + 9.75 + 77$

$= 125 \text{ in}^2$

$w = 425$ PLF

$I_{3-3} = 4 \times 6.75 \times (38.5 - 1.47)^2 +$

$\frac{1}{12} \times 77^3 \times 1/2 \times 2 + 11.25 \times (38.5)^2$

$+ 9.75 \times 38.5^2$

$= 37{,}023 + 38{,}044 + 31{,}127 = 106{,}194$

$S_{3-3} = 2760$

$S_{3-8} = 1510$

$I_{3-3} = 4 \times 6.25 \times (15 - 2.47)^2 + 2 \times 38.5 \times 15^2$

$+ \frac{1}{12} \times 30^3 \times 3/8 + \frac{1}{12} \times 26^3 \times 3/8$

$= 3925 + 17{,}325 + 844 + 549 = 22{,}643$

-11 / 6-13 : same as for 1-4 / 3-6 except

$h = \frac{79 + 86}{2} = 82.5''$

$\Sigma A = 27 + 11.25 + 9.75 + 2 \times 41$

$= 130 \text{ in}^2$

$w = 442$ PLF

$I_{3-3} = 27 \times (41 - 1.47)^2 + \frac{1}{12} \times 82^3 \times 1/2 \times 2$

$+ 11.25 \times (41)^2 + 9.75 \times 41^2$

$= 42{,}190 + 45{,}947 + 18{,}911 + 16{,}389 = 123{,}438$

$I_{3-3} = 3929 + 82 \times 15^2 + 844 + 549$

$= 23{,}772$

Member properties

11-18, 13-20 : 4 ∠ 8 × 8 × 7/8 , Top PL - 30 × 3/8 A = 11.25

A = 13.2

$\bar{x}$ = 2.32 Bottom PL - 26 × 3/8 A = 9.75

Web PL - 1/2 × 91 , A = 45.5

$h = \frac{86 + 96}{2} = 91''$

$\Sigma A = 4 \times 13.2 + 11.25 + 9.75 + 2 \times 45.5$

52.8

= 164.8

w = 507 PLF.

$I_{2-2} = 52.8 \times (45.5 - 2.32)^2 + 11.25 \times 45.5^2 + 9.75 \times 45.5^2$

$+ \frac{1}{12} \times 91^3 \times$

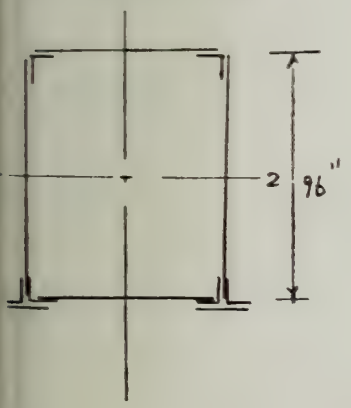
= 98,446 + 23,290 + 20185 + 62,798

= 204,720 in⁴

$I_{3-3} = 52.8 \times (15 - 2.32)^2 + 2 \times 45.5 \times 15^2 + 844 + 549$

= 8489 + 20,475 + 844 + 549 = 30,351

18-21/20-23 :




2-∠s 8 × 8 × 7/8 , A = 13.2 , $\bar{x}$ = 2.32

2-2∠s 8 × 4 × 1 , A = 22 , $\bar{x}$ = 1.05

Top PL , 30 × 3/8 , A = 11.25

Bottom PL , 26 × 3/8 A = 9.75

12 × 3/8 A = 2 × 4.5

Web PL , 1/2 × 96 A = 96

$\Sigma A = 2 \times 13.2 + 2 \times 22 + 11.25 + 9.75 + 9 \times 96$

= 196.4

w = 675 PLF

$I_{2-2} = 2 \times 13.2 \times (48 - 2.32)^2 + 44 \times (48 - 1.05)^2$

$+ \frac{1}{12} \times 96^3 + (11.25 + 9.75) \times 48^2 + 9 \times 48^2$

= 55,087 + 98,989 + 73778 + 69,120 = 294,974

$I_{3-3} = 2 \times 13.2 \times (15 - 2.32)^2 + 2 \times 22 \times (15 - 1.05)^2$

$+ 844 + 549 + 9 \times 15^2 + 96 \times 15^2 = 37,825$

Member properties

18-21 / 20-23 :

Top : $\angle 8 \times 8 \times 7/8$ $A = 13.2$, $\bar{x} = 2.32$

$\square$ $30 \times 3/8$ $A = 11.25$

Bottom : $2 \angle 5 \times 4 \times 1$, $A = 22$, $x = 1.05$

$\square$ $44 \times 3/4$, $A = 33$

$\square$ $12 \times 3/4$ $A = 9$

Web : $1/2 \times 96$

$\Sigma A = 2 \times 13.2 + 11.25 + 44 + 33 + 18 + 96$

$= 228.65$

$w = 756$ PLF

$$\bar{x} = \frac{26.4 \times (96 - 2.32) + 11.25 \times 96 + 96 \times 48}{228.65}$$

$$= \frac{2473 + 1080 + 4608}{228.65} = 35.7 \approx 36$$

$I_{2-2} = 26.4 \times (60 - 2.32)^2 + 11.25 \times 60^2 + \frac{1}{12} \times 96^3$
87,832 40,500 73,728

$+ 96 \times (60 - 48)^2 + 44 \times (38 - 1.05)^2 + (33 + 18) \cdot 36$
13,824 53,744 61,096

$= 335,726$

$S_{2-2} = 7298$

$I_{3-3} = 26.4 (15 - 2.32)^2 + \frac{1}{12} 130^3 \times 3/8 + 96 \times 15^2$
4,245 844 21,600

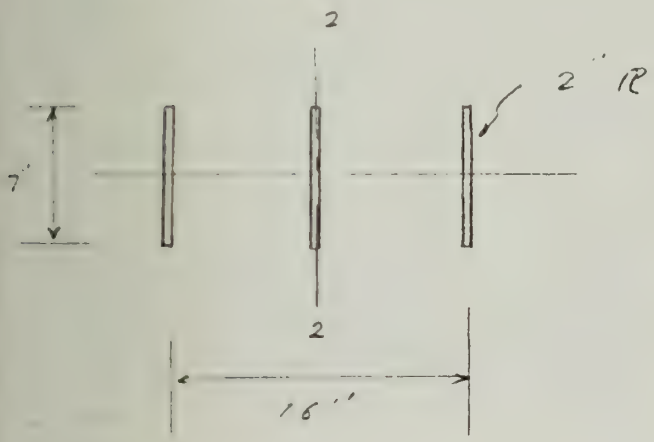
$+ 44 \times 15^2 + \frac{1}{12} \times 44^3 \times 3/4 + 18 \times 15^2$
9900 5324 4050

$= 45,968$

$S_{3-3} = 3,064$

Trunnion Supports

Elements 22, 23, 24 : section properties may be simplified as follows

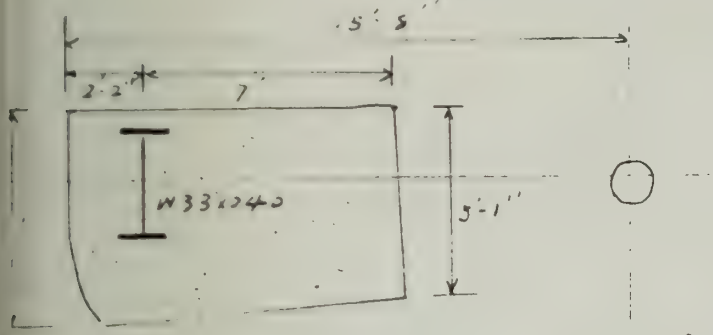



$A = 102 \text{ in}^2$

$I_{2-2} = 2 \times 34 \times 64 = 4352 \text{ in}^4$

$I_{3-3} = \frac{1}{12} \times 2 \times 17^3 \times 3 = 2457 \text{ in}^4$

Counterweight - Drawing # 15

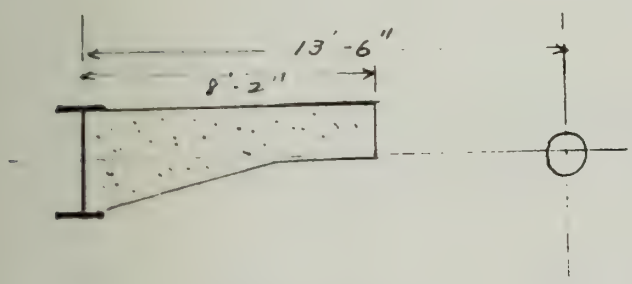



$A = \frac{6+5}{2} \times 9 = 50\ ft^2$

unit wt $= 50 \times 150\ \#/ft^3 + 240$

$= 7{,}740\ lb/ft$

℄ of Trunnion

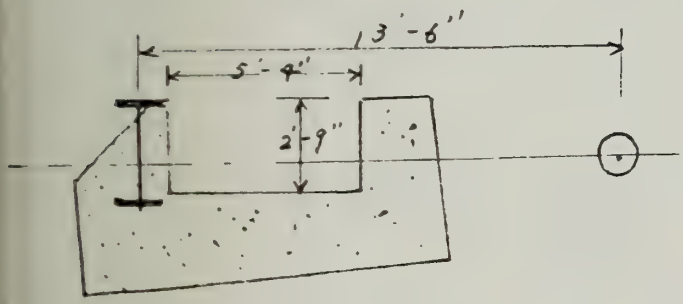



$A = \left[\frac{33+20}{2} \times 66 + 20 \times 30\right] / 144$

$= 16.3\ ft^2$

unit wt $= 16.3 \times 150 + 240$

$= 2690\ lb/ft$




$A = 50 - 0.5 \times 9 - 5.33 \times 2.75$

$= 50 - 4.5 - 14.7 = 30.8$

unit $= 30.8 \times 150 + 240$

$= 4{,}400\ lb/ft$

Total CTWT $= 7.74 \times 4.5' + 2.69 \times (4.83 + 6.5)$

$+ 30.8 \times 14 + (50 - 4.5) \times (32 - 14)$

$= 34.83 + 30.48 + 431 + 819$

$= 1315$ Kips + Adjusting Blocks @ 75 #/ea

N. pit. $= (610 + 370) \times 0.075 + 43.7$ (steel & plate)

$= 117^K$

S. pit $= (590 + 325) \times 0.075 + 25.3$ (steel & plate)

$= 94^K$

Sum: 1,432 Kip @ North, & 1409 K @ South

Floor wt.

Sidewalk :

3 - C 10 x 15.3 @ 7' = 964# } per 16.5 x 7' ft²
1 - L 3 x 3 x 3/8 @ 7.2 /ft = 150# }
= 10 psf

Grating + supporting = 25 psf (assumed)
35 psf

Main Floor :

10 - W 8 x 47 @ 16.5' = 7755 } per 41.5 x 16.5
Bracing - 2 C 4 x 7.25 = 300 }
= 12 psf

Grating + supporting = 33 psf (assumed)
45 psf

Concrete curb :

$2.5 \times \frac{11.5}{12} \times 150 = 0.36$ k/ft

static check

Take moment @ Trunnion

(2 × 21.1 + 33) × 56 = 4211 k-ft

(2 × 39.7 + 61) × 39.5 = 5,546

(2 × 41.1 + 63.4) × 23 = 3349

(2 × 31.7 + 48.9) × 6.5 = 318

13,424 k-ft

13,424 / 1400* = 9.59 × 12 = 115"

℄ of CTWT = (182 − 64)/2 + 64 = 113" Tony = K

* A CTWT = 1432 k @ North
1409 k @ South } use 1400 k

Results of Seismic Evaluation - 3rd Street Bridge
Over Islais Creek (Closed Condition)

| Member* I.D. | Element Type | $F_a$ (Ksi) | $F_b$ (Ksi) | Dead plus Seismic ** | | |
|---|---|---|---|---|---|---|
| | | | | $f_a$ (Ksi) | $f_b$ (Ksi) | $\frac{f_a}{1.7F_a} + \frac{f_b}{1.7F_b}$ |
| 1, 3 | Girder | - | 18.0 | - | 2.1 | 0.07 |
| 4, 6 | | - | | - | 8.9 | 0.29 |
| 5 | | - | | - | 7.9 | 0.26 |
| 8 | | - | | - | 10.5 | 0.34 |
| 11 | | - | | - | 9.9 | 0.32 |
| 13, 15 | | - | | - | 7.5 | 0.25 |
| 14 | Girder | - | 18.0 | - | 9.4 | 0.31 |
| 1 ~ 4 | Bracing | 18.0 | - | 23.0 | - | 0.75 |
| 5 ~ 8 | " | 18.0 | - | 20.9 | - | 0.70 |
| 9 ~ 12 | " | 18.0 | - | 16.6 | - | 0.55 |

* See Figure 2 for member locations

** For the critical load combination

SF. BRIDGE : GROUP V-3

TABLE 2

computer outputs - vert. Load

| Member | A | $S_{2-2}$ | $S_{3-3}$ | closed | | 60° open | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{3-3}$ | $M_{2-2}$ | P | $V_{3-3}$ | $M_{2-2}$ | $M_{3-3}$ |
| 1, 3 | 125 | 2,760 | 1,510 | 21 | 4,178 | 17.9 | 10.5 | 2,089 | |
| 2 | 144 | 3,422 | 1,718 | 33 | 6,534 | 27.4 | 16.5 | 3,267 | |
| 4, 6 | 130 | 3,208 | 1,584 | 61 | 16,200 | 52.3 | 30.4 | 8,108 | |
| 5 | 152 | 3,833 | 1,905 | 94 | 25,150 | 80.2 | 47.0 | 12,570 | |
| 7, 9 | 165 | 5,317 | 2,024 | 102 | 36,390 | 87.8 | 51.0 | 18,200 | |
| 8 | 217 | 6,019 | 2,757 | 158 | 56,310 | 135.1 | 78.7 | 28,160 | |
| 10, 12 | 229 | 6,994 | 3,064 | 134 | 46,810 | 116.0 | 66.8 | 23,410 | |
| 11 | 240 | 8,206 | 3,101 | 206 | 72,400 | 178.4 | 103.1 | 36,200 | |
| 13, 15 | 229 | 6,994 | 3,064 | 404 | 45,390 | 375. | 216.0 | 22,720 | |
| 14 | 240 | 8,206 | 3,101 | 593 | 70,220 | 462 | 269.0 | 35,060 | |
| | | | | P | $M_{2-2}$ | P | $M_{2-2}$ | | |
| 22 | Trunnion support | | | 552 | 1,447 | 581 | 653 | | |
| 23 | | | | 814 | 2,181 | 756 | 1208 | | |
| 24 | | | | 552 | 1,447 | 581 | 653 | | |

Deflection @ free end:

$\delta_y = 1.08''$ $\delta_y = 0.35''$

$\delta_x = 0.58''$

@ CTWT:

$\delta_y = 0.012''$ $\delta_y = 0.013''$

$\delta_x = 0.002''$

FS/BLUME
) essie Street (at New Montgomery)
n Francisco, California 94105

SHEET NO. 15

JOB S. F. Bridge BY CKC DATE 8/13/84

SUBJECT Islais Bridge - closed CHK'D DATE

## computer outputs - E.Q. Load

| Member | X-Dir. (Longit. Dir.) | | | Y-Dir. (Vert) | | Z-Dir. (Trans. Dir.) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P | $M_{2-2}$ | | V | $M_{2-2}$ | P | V | $M_{2-2}$ | $M_{3-3}$ |
| 1, 3 | 13.2 | 1,130 | | 30.9 | 6,106 | 39.4 | 15.8 | 514 | 3,157 |
| 2 | 20.0 | 1,320 | | 40.0 | 7,901 | - | 20.2 | - | 4,002 |
| 4, 6 | 38.6 | 3,435 | | 39.2 | 13,240 | 50.0 | 13.6 | 1,733 | 3,137 |
| 5 | 59.6 | 4,010 | | 49.1 | 17,050 | - | 18.9 | - | 4,002 |
| 7, 9 | 64.7 | 6,188 | | 42.1 | 19,100 | 63.4 | 35.0 | 3,140 | 6,330 |
| 8 | 100.0 | 7,284 | | 46.5 | 23,520 | - | 36.7 | - | 6,957 |
| 10, 12 | 85.1 | 7,290 | | 42.2 | 21,550 | 108.0 | 92.4 | 3,704 | 13,540 |
| 11 | 131.0 | 8,608 | | 46.5 | 26,040 | - | 95.8 | - | 14,420 |
| 13, 15 | 313.0 | 2,474 | | 209 | 23,810 | 224.2 | 235.0 | 4,607 | 16,740 |
| 14 | 268 | 2,665 | | 238 | 28,040 | - | 237.0 | - | 17,530 |
| Support | $V_{3-3}$ | P | $M_{2-2}$ | P | $M_{2-2}$ | $M_{2-2}$ | $M_{3-3}$ | $V_{2-2}$ | $V_{3-3}$ |
| 22 | 408 | 24.2 | 7,795 | 242 | 4415 | 4,161 | 3836 | 284 | 317 |
| 23 | 409 | 33.0 | 7,855 | 272 | 4432 | - | 3854 | 285.5 | |
| 24 | 408 | 24.2 | 7,795 | 242 | 4415 | 4,161 | 3836 | 284 | 317 |
| Bracing | | | | | | P | | | |
| 1 ~ 4 | | | | | | 49 | | | |
| 5 ~ 8 | | | | | | 56 | | | |
| 9 - 12 | | | | | | 60 | | | |

Deflection: @ Free End :

$\delta_x = 0.327$ $\delta_x = 0.016$ $\delta_x = 0.25$

$\delta_y = 0.97$ $\delta_y = 0.62$ $\delta_y = 0.10$

$\delta_z = 1.12$

@ CTNT :

$\delta_x = 0.32$ $\delta_x = 0.25$

$\delta_y = 0.20$ $\delta_y = 0.19$ $\delta_z = 0.25$

Periods:

$T_1 = 0.86$ (coupling Mode) $T_1 = 0.86$ (coupling) $T_2 = 0.34$

$T_5 = 0.23$ $T_8 = 0.13$ $T_6 = 0.23$

Bracing : Tension in action only

① - ④ : $p = 2 \times 49$

Demand : $p = 2 \times 49 / z$ $z = 2.0$

$= 49$

Capacity : $A = 2.13$ w/ 3 rivets

C 4 × 7.25# w/ 3 rivets

$p = 2.13 \times 0.6 F_y \times 1.7 = 64^k >$ Demand o.k.

$p = 3 \times 12 \times 1.3$ ... oss. 3 - 7/8 φ rivets

$= 47^k \approx$ Demand o.k

⑤ - ⑧ : $p = 56 \times 2$ kips

Demand : $p = 56 \times 2 / z = 56^k$

Capacity : $p = 2.68 \times 30 = 80^k >$ Demand o.k

∠5×3×3/8 w/ 6 rivets

$= 6 \times 12 \times 1.3 = 93.6 >$ Demand o.k

⑨ - ⑫ : $p = 2 \times 60 = 120$

Demand : $p = 120 / z = 60^k$

Capacity : $p = 3.61 \times 30 = 108^k > 60$ o.k.

∠6×4×3/8 w/ 6 rivets

$= 6 \times 12 \times 1.3 = 93.6 >$ Demand o.k

Girders $Z = 3.0$

△1 : Demand :

$M_{2-2} = 4,178 + (1130 + 0.67 \times 5,106)/Z$

D.L. EQ.X EQ.-Y

$= 5,918$ k-in

$\sigma_{2-2} = M_{2-2} / S_{2-2} = 5918/2760 = 2.14$ ksi

$M_{3-3} = 3,137/Z = 1,046$ k-in

EQ.Z

$\sigma_{3-3} = 1,046/1510 = 0.7$

Capacity :

$f_b = 0.6 \times F_y \times 1.7 = 30$ ksi >> Demand

△4 / △5 : Demand :

$M_{2-2} = 16,220 + (3,435 + 0.67 \times 13,240)/Z$

D.L. EQ.X EQ.Y

$= 28,526$ k-in

$\sigma_{2-2} = M_{2-2} / S_{2-2} = 28,536/3208$ < capacity

$= 8.9$ ksi

$M_{3-3} = 3,137/Z = 1046$

EQ.Z

$\sigma_{3-3} = 1046/1584 = 0.7$ < capacity

Girders

5 : Demand -

$M_{2-2} = 25{,}150 + (4{,}010 + 0.67 \times 17{,}050)/z$
D.L. E.Q. X E.Q. Y

$= 30{,}295$ k-in

$\sigma_{2-2} = 30295/3833 = 7.9$ ksi O.K

$M_{3-3} = 4{,}002/z$

$= 1{,}334$

$\sigma_{3-3} = 1{,}334/1905 = 0.7$ O.K

8 : Demand -

$M_{2-2} = 56{,}310 + (7{,}284 + 0.67 \times 23{,}520)/z$
D.L. E.Q. X E.Q. Y

$= 63{,}991$ k-in

$\sigma_{2-2} = 63{,}991/6108 = 10.5$ ksi O.K.

$M_{3-3} = 6{,}957/z$
E.Q. Z

$\sigma_{3-3} = 0.84$ ksi O.K

11 : Demand -

$M_{2-2} = 72{,}400 + (8608 + 0.67 \times 26{,}040)/z$
D.L E.Q. X E.Q. Y

$= 81{,}085$

$\sigma_{2-2} = 81085/8206 = 9.9$ ksi O.K.

$M_{3-3} = 14{,}420/z$

$\sigma_{3-3} = M_{3-3}/3102 = 1.55$ ksi O.K

Girders

13 / 15 :

$M_{2-2} = 45,390 + (4,607 + .67 \times 23,810)/2$

D.L. E.Q. Z E.Q. Y

$= 52,243$ K-in

$\sigma_{2-2} = 52,243/6894 = 7.5$ ksi

$M_{3-3} = 16,740/2$

E.Q. Z

$= 3,580$

$\sigma_{3-3} = 5580/3,064 = 1.8$ ksi

14 :

$M_{2-2} = 70,220 + (2,665 + 0.67 \times 28,040)/2$

D.L. E.Q. X E.Q. Y

$= 77,371$ K-in

$\sigma_{2-2} = 77371/8206 = 9.4$ ksi O.K

Trunnion Supports $Z = 2.0$

Side Support : Demand

$P = 552 \pm (442 + 0.67 \times 242)/Z$ ($\pm$ 302)

D.L. EQ.Z EQ.Y

$= 854$ kips or $250$ kips

$V_{2-2} = 284/Z = 142$ kips

EQ.Z

$V_{3-3} = (408 + 0.3 \times 317)/Z$

E.Q.X + EQ.Z

$= 251$ kips

$M_{2-2} = 1{,}447 + (7795 + 0.67 \times 4415)/Z$

EQ.X EQ.Y

$= 6{,}824$ K-in

$M_{3-3} = 3836/Z = 1918$ K-in

EQ.Z

Center Support :

$P = 814 \pm (272)/Z$

D.L. EQ.Y

$= 950$ or $678$ kips

$V_{2-2} = 286/Z = 143$ kips

EQ.Z

$V_{3-3} = (409 + 0.67 \times 19.2)/Z$

EQ.X + EQ.Y

$= 211$ kips

$M_{2-2} = 2{,}181 + (7855 + 0.67 \times 4432)/Z$

$= 7{,}593$ kips-in

$M_{3-3} = 3{,}854/Z = 1927$ K-in

Trannion Support capacity

Axial : W14 x 356 $A = 105 \text{ in}^2$

$r = 4.25$

$Kl/r = 33$ $l = 11.5 \times 12$

$K = 1.0$

$F_a = 19.73 \times \frac{30}{36} = 16.4$ ksi

$P_{cap} = 16.4 \times 105 \times 1.7 = 2927$ K

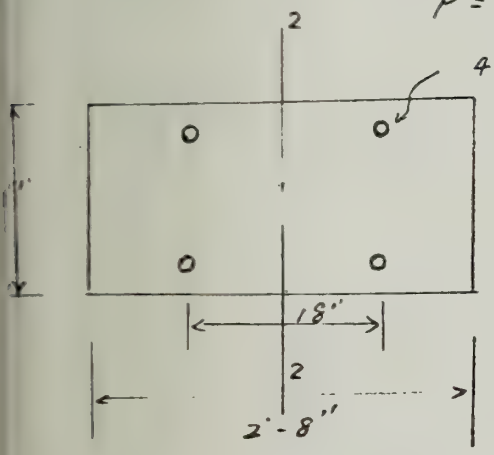
Shear : 4 - 1 3/4" ϕ Bolts ( high strength bolt ? )

Let use $F_v = 30$ ksi

$V_{cap} = 4 \times 2.4 \times 30 = 288$ kips

Flexure : center support -

$P = 950$ K. $M_{2-2} = 7593$ K-in



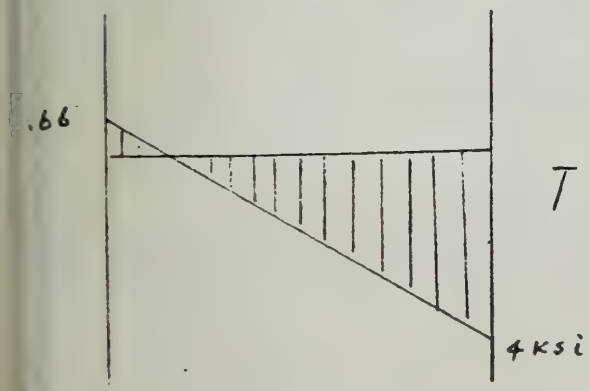

$A = 17 \times 34 = 578$

$I_{2-2} = \frac{1}{12} \times 34^3 \times 17 = 55{,}680$

$f = \frac{P}{A} \pm \frac{Mc}{I}$

$= \frac{950}{578} \pm \frac{7593 \times 17}{55680}$

$= 1.64 \pm 2.3 = 4$ ksi, $-0.66$ ksi




$x/4 = \frac{34 - x}{0.66}$, $x = 29.2$"

$C = \frac{1}{2} \times 17 \times 29.2 \times 4 = 993$ K

$T = P - C = 950 - 993 = -43$ K

= Tension

∴ No tension occurs @ anchor bolts.

Comparison of Member Forces for the
Bridge in Closed and Open Conditions

| Member* I.D. | Element Type | Dead Load plus Seismic** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bridge in Closed Condition | | | | | Bridge in Open Condition (60°) | | | | |
| | | P (Kips) | $V_{2-2}$ (Kips) | $V_{3-3}$ (Kips) | $M_{2-2}$ (Kips) | $M_{3-3}$ (Kips) | P (Kips) | $V_{2-2}$ (Kips) | $V_{3-3}$ (Kips) | $M_{2-2}$ (K-in.) | $M_{3-3}$ (K-in.) |
| 1, 3 | Girder | - | - | - | 5,918 | - | - | - | - | 4,467 | - |
| 4, 6 | ↑ | - | - | - | 28,560 | - | - | - | - | 14,610 | - |
| 5 | | - | - | - | 30,300 | - | - | - | - | 18,290 | - |
| 8 | | - | - | - | 64,000 | - | - | - | - | 27,640 | - |
| 11 | | - | - | - | 81,000 | - | - | - | - | 68,980 | - |
| 13, 15 | ↓ | - | - | - | 52,200 | - | - | - | - | 37,530 | - |
| 14 | Girder | - | - | - | 77,370 | - | - | - | - | 47,730 | - |
| 22, 24 | Trunnion Support | 854 | 144 | 251 | - | - | 861 | 125 | 239 | - | - |
| 23 | | 950 | 143 | 211 | - | - | 834 | 126 | 216 | - | - |
| 1~4 | Bracing | 49 | - | - | - | - | 51 | - | - | - | - |
| 5~8 | " | 56 | - | - | - | - | 57 | - | - | - | - |
| 9~12 | " | 60 | - | - | - | - | 61 | - | - | - | - |

* See Figure 2 for member locations

** For the critical load combination.

F. BRIDGE : GROUP V-3

TABLE 3

JFS/BLUME
30 Jessie Street (at New Montgomery)
San Francisco, California 94105

SHEET NO. 23

JOB NO. | JOB S. F. Bridge | BY CKC | DATE 8/14/84
SUBJECT Islais Bridge - open 60° | CHK'D | DATE

computer outputs

| Member | X - Dir. - Longit. | | | Y - Dir. - Vert | | Z - Dir. - Trans. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P | V | $M_{2-2}$ | V | $M_{2-2}$ | P | V | $M_{2-2}$ | $M_{3-3}$ |
| 1, 3 | 5.6 | 17.3 | 3,247 | -16 | 3,205 | 40 | | 4,987 | 3,154 |
| 2 | 8.7 | 17.2 | 3,407 | 27.6 | 5,470 | - | | - | 4,026 |
| 4, 6 | 16.4 | 39.3 | 11,190 | 15.0 | 6,126 | 45.5 | | 15,410 | 3,154 |
| 5 | 25.4 | 38.2 | 10,860 | 20.5 | 9,383 | - | | - | 4,026 |
| 7, 9 | 27.6 | 55.8 | 22,150 | 9.0 | 5,784 | 49.0 | | 28,190 | 6,228 |
| 8 | 42.7 | 58.0 | 22,020 | 20.8 | 9,383 | - | | - | 6,830 |
| 10, 12 | 36.3 | 68.5 | 27,460 | 16.9 | 5,784 | 96.0 | | 33,390 | 13,550 |
| 11 | 560 | 764 | 27,830 | 35.8 | 7,389 | - | | - | 14,220 |
| 13, 15 | 134 | 300 | 34,690 | 45.0 | 5,778 | 4.80 | 230 | 32,500 | 17,680 |
| 14 | 168 | 281 | 33,610 | 53.7 | 6,585 | - | 216 | - | 18,540 |
| | V | P | $M_{2-2}$ | P | $M_{2-2}$ | P | $M_{2-2}$ | $M_{3-3}$ | $V_{2-2}/V_{3-3}$ |
| 22 | 404 | 78 | 9576 | 85.9 | 2207 | 502 | 4,064 | 3,376 | 250/247 |
| 23 | 404 | 121 | 9721 | 88.3 | 2277 | - | - | 3391 | 251/0 |
| 24 | 404 | 78 | 9576 | 85.9 | 2207 | 502 | 4,064 | 3376 | 250/247 |
| Bracing | | | | | | P | | | |
| 1-4 | | | | | | 51.0 | | | |
| 5-8 | | | | | | 57.0 | | | |
| 9-12 | | | | | | 61.0 | | | |

Deflections @ free end:

$\delta_x = 1.34''$ $\delta_x = 0.28''$ $\delta_x = 0.93''$
$\delta_y = 0.74''$ $\delta_y = 0.16''$ $\delta_y = 0.51''$
$\delta_z = 1.03''$

@ CTWT:

$\delta_x = 0.48''$ $\delta_x = 0.06$ $\delta_x = 0.2$
$\delta_y = 0.17''$ $\delta_y = 0.04$ $\delta_z = 0.2$

predominate T's:

$T_1 = 0.86$ (coupling mode) $T_1 = 0.86$ (coupling) $T_3 = 0.33$
$T_5 = 0.24$ sec. $T_9 = 0.10$ $T_4 = 0.31$
$T_6 = 0.21$

Bracing

① - ④ : $p = 2 \times 51$

Demand - $p = 2 \times 51/2 = 51^K$

Capacity - $p = 64 >$ Demand o.K

$p = 47^K < 51^K$ slightly exceed.

⑤ - ⑧ : $p = 57 \times 2$

Demand - $p = 57^K$

capacity - $p = 80 >$ Demand o.K

$p = 93.6 >$ Demand o.K

⑨ - ⑫ : $p = 2 \times 61$

Demand - $p = 61$

Capacity - $p = 108 >$ Demand - Member

$p = 93.6 >$ Demand - connection

Girders

△ :

$M_{2-2} = 2{,}089 + (4{,}987 + 0.67 \times 3205)/2$
D.L. EQ.Z EQ.Y
$= 4{,}467$ K-in

$\sigma_{2-2} = 4{,}467/2760 = 1.62 < 30$ ksi O.K

$M_{3-3} = 3154/2$
$= 1051$ K-in

$\sigma_{3-3} = 1051/1510 = 0.7 < 30$ O.K

△/△ : $M_{2-2} = 8{,}108 + (15{,}410 + 0.67 \times 6120)/2$
D.L. EQ.Z EQ.Y

$= 14{,}611$ K-in

$\sigma_{2-2} = 14{,}611/3208 = 4.6$ ksi $< 30$ ksi O.K.

$M_{3-3} = 3{,}154/2 = 1{,}051$

$\sigma_{3-3} = 1051/1{,}584 = 0.7$ ksi $< 30$ ksi O.K.

△ : $M_{2-2} = 12{,}570 + (10{,}860 + 0.67 \times 9383)/2$
D.L. EQ.X EQ.Y
$= 18{,}285$

$\sigma_{2-2} = 18{,}285/3{,}833 = 4.8$ ksi $< 30$ O.K.

$M_{3-3} = 4{,}026/2 = 1{,}342$

$\sigma_{3-3} = 1342/1905 = 0.70$ ksi. O.K.

Girders

8 : Demand -

$M_{2-2} = 18{,}200 + (22{,}020 + 0.67 \times 9383)/2$
D.L. EQ. X EQ. Y

$= 27{,}635$ k-in

$\sigma_{2-2} = 27{,}635/6019 = 4.6$ ksi < O.K.

$M_{3-3} = 6{,}380/2 = 2{,}127$

$\sigma_{3-3} = 2127/2{,}757 = 0.8$ O.K.

11 : $M_{2-2} = 36{,}200 + (27{,}830 + 0.67 \times 7{,}389)/2$
D.L. EQ. X EQ. Y

$= 68{,}980$

$\sigma_{2-2} = 68{,}980/8{,}202 = 8.4$ ksi O.K.

$M_{3-3} = 14{,}220/2 = 4{,}740$

$\sigma_{3-3} = 4{,}740/3102 = 1.5$ ksi O.K.

13 / 15 : $M_{2-2} = 22{,}720 + (34{,}690 + 0.3 \times 32{,}300)/2$
D.L. EQ. X EQ. Z

$= 37{,}533$ k-in

$\sigma_{2-2} = 37{,}533/6994 = 5.4$ ksi O.K.

$M_{3-3} = 17{,}680/2 = 5{,}893$

$\sigma_{3-3} = 1.9$ ksi O.K

14 : $M_{2-2} = 35{,}060 + (33{,}610 + 0.67 \times 6585)/2$
D.L EQ. X EQ Y

$= 47{,}733$

$\sigma_{2-2} = 47733/8206 = 5.8$ ksi O.K.

$M_{3-3} = 18{,}540/2 = 6{,}180$ $\sigma_{3-3} = 2.0$ O.K

Trunnion Supports $Z = 2.0$

Side Support - Demand

$P = 581 \pm (502 + 0.67 \times 85.9)/Z$
D.L. EQ. Z + EQ Y

$= 861$ or $301$ kips

$V_{2-2} = 250/Z = 125$ kips
EQ. Z

$V_{3-3} = (404 + 0.3 \times 247)/Z$
EQ. X EQ. Z

$= 235$ kips

$M_{2-2} = 653 + (9576 + 0.67 \times 2{,}207)/Z$
D.L. EQ. X + EQ. Y

$= 6{,}180$ k-in.

$M_{3-3} = 3376/Z = 1688$ k-in
EQ. Z

Center Support - Demand

$P = 756 \pm (121 + 85.9 \times 0.67)/Z$
D.L. EQ. X + EQ. Y
129

$= 834$ or $577$ kips

$V_{2-2} = 251/Z = 126$
EQ Z

$V_{3-3} = (404 + 0.67 \times 40)/Z = 216$ k
EQ. X + EQ Y

$M_{2-2} = 1208 + (9721 + 0.67 \times 2277)/Z$
D.L. EQ. X EQ. Y
5623

$= 6{,}831$

$M_{3-3} = 3391/Z = 1{,}696$ k-in
(EQ Z)

ACCOPRESS®

| | |
|---|---|
| 25070 | YELLOW |
| 25071 | BLACK |
| 25072 | LIGHT BLUE |
| 25073 | DARK BLUE |
| 25074 | LIGHT GRAY |
| 25075 | LIGHT GREEN |
| 25076 | DARK GREEN |
| 25077 | TANGERINE |
| 25078 | RED |
| 25079 | EXECUTIVE RED |

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